TRANSACTIONS OF THE

American Foundrymen's Association

Proceedings of the

Twenty-third Annual Meeting

MILWAUKEE, WIS.

October 7 to 11, 1918

VOLUME XXVII

Edited by

H. COLE ESTEP

Published by the American Foundrymen's Association
Cleveland, Ohio
1919

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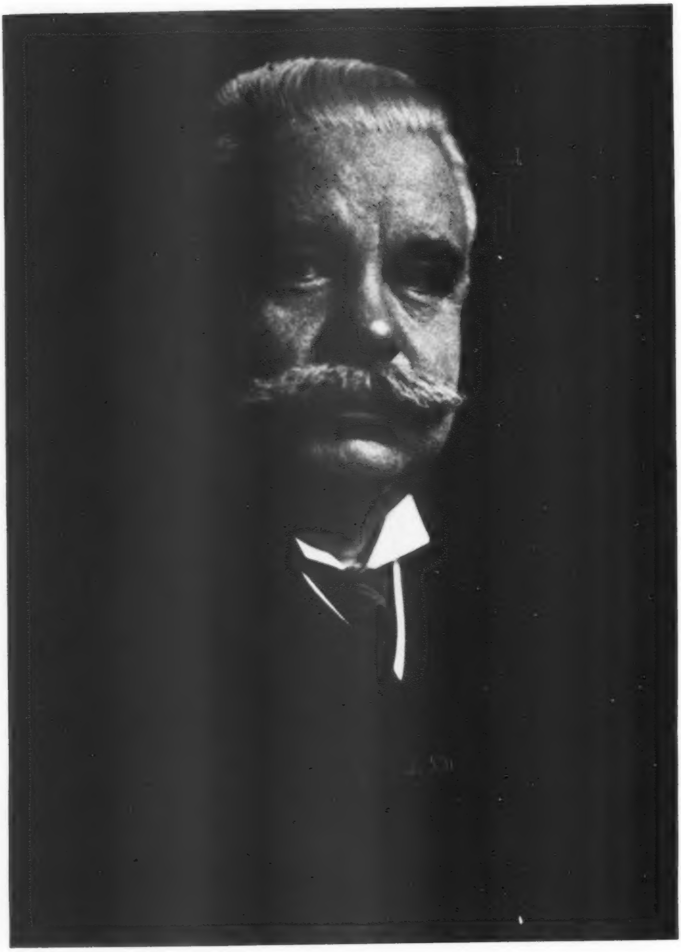


Jos G Cannon

Joseph T. Speer
Past President, American Foundrymen's Association

Major Joseph T. Speer

Major Joseph T. Speer, one of the leaders of the foundry industry of the United States, past president of the American Foundrymen's association, and prominently identified with the great organized movements on technical development in that field, died at Pittsburgh, Jan. 5. At the time of his death, he was chairman of the Pittsburgh Valve Foundry & Construction Co., and one of the prominent figures in Pittsburgh industrial circles.

Major Speer and the interests with which he had been affiliated were pioneers in several branches of the foundry business. He himself made the work of foundry advancement in all its allied lines, a life undertaking. He was born in Pittsburgh. Immediately after graduating from Western university, now the University of Pittsburgh, he became connected with the firm of Hall & Speer, plow manufacturers, of which his father, Alexander Speer, was senior member. After four years, during which he served his apprenticeship as patternmaker, he spent four months in Europe. He returned to Pittsburgh, with the firm of Hall & Speer, and became an active foundryman, devoting his attention entirely to the foundry end of the business, which in 1874 was changed in title to Alexander Speer & Sons. William W. Speer, a brother of the major, became the head of the business on the death of Alexander Speer, in 1876. In 1878 Major Speer took charge of South America, Central America and the West Indies. He remained in the tropics until 1896.

Returning permanently to the United States, Major Speer succeeded to the management of Alexander Speer & Sons in 1897. He continued that position until November, 1899, when the present Pittsburgh Valve Foundry & Construction Co. was organized by the consolidation of the firms of Atwood & McCaffery; Shook, Anderson Mfg. Co.; Pittsburgh Valve & Machine Co.; the pipe fitting department of Wilson &

Snyder and the foundry department of Alexander Speer & Sons. The late Henry L. Atwood was president of the new company for two years when the position of chairman of the board of directors was created and Major Speer succeeded to the presidency and active management. Upon the retirement of Mr. Atwood as chairman of the board three years ago, he was succeeded by Major Speer.

From this time Major Speer not only was actively connected with the foundry business in his own plant, but he also became identified with the progress of the business throughout the country. He bent his endeavor to the improvement and advancement of the business, particularly as applied to the manufacture of gray iron and steel in high pressure usages. He was among the first to take up the study of semisteel which he applied to the manufacture of valves.

Until the time of his death, Major Speer took an active interest in the affairs of the American Foundrymen's association. He was vice president from 1908 to 1909 and at the Pittsburgh meeting in 1911 he was elected president, having served two terms, namely 1911 and 1912. When he retired from the office of president, he was elected an honorary member of the association. He also was active in the affairs of the Pittsburgh Foundrymen's association and served two terms as its president.

Summary of the Proceedings of the Twenty-third Annual Meeting

Milwaukee, Wis., October 8 to 11, 1918.

Prosaically termed the twenty-third annual meeting, the Milwaukee convention of the American Foundrymen's association was in reality a great win-the-war effort of tangible value to the government. The war problems of the foundry industry were given earnest consideration from the opening session on Tuesday, Oct. 8, to the closing meeting at noon on Friday, Oct. 11. In the first instance a stirring, patriotic resolution was telegraphed to President Wilson and at the final session a member of the ordnance department described in detail the problems involved in machining semisteel shells. At the intervening sessions, the war problems of the foundry industry were thoroughly discussed, special attention being devoted to the manufacture of cast ammunition and to the production of steel castings for ordnance purposes.

In spite of the large number of foundrymen engaged on war work of vital importance, the attendance was unusually heavy. The registration of members of the allied societies exceeded all previous records, totalling 1056 for the three associations, including 771 members of the American Foundrymen's association. Eight technical sessions were held. The first session on Tuesday, Oct. 8, was conducted jointly with the Institute of Metals division of the American Institute of Mining and Metallurgical Engineers. There were three sessions on general topics on Tuesday, Wednesday and Friday respectively. A session specially devoted to gray-iron foundry problems was held on Thursday simultaneously with the malleable and steel sessions. A new feature was introduced, on Wednesday, in the shape of a session on safety and acci-

dent prevention. The three simultaneous sessions which were held on Thursday were made necessary by the tremendous scope of the convention and the great volume of work accomplished. The latter may be measured from the fact that there were 53 titles on the program of the American Foundrymen's association.

Joint Opening Session

Tuesday, Oct 8, 10 *a. m., Plankinton Hall*

The convention was formally opened by a joint opening session of the Institute of Metals division and Iron and Steel section of the American Institute of Mining and Metallurgical Engineers and the American Foundrymen's association in Plankinton Hall, Milwaukee Auditorium, at 10 a. m., Tuesday, Oct. 8.

Benjamin D. Fuller, president of the American Foundrymen's association, occupied the chair.

An address of welcome was delivered by the Hon. Emanuel L. Phillipp, governor of Wisconsin. Response was made on behalf of the allied societies by Benjamin D. Fuller, president of the American Foundrymen's association.

Following the address of welcome and response, a message from the western front from Captain R. A. Bull, A. E. F., past president of the American Foundrymen's association, was read by the secretary. Captain Bull's masterly letter, which was received with tremendous applause, formed the inspiration for a patriotic resolution introduced by V. E. Minich, New York. This resolution was unanimously passed by a rising vote and immediately telegraphed to the President of the United States. The text of the resolution follows:

> "*Resolved,* by the American Foundrymen's association, Institute of Metals division of the American Institute of Mining Engineers, the Iron and Steel section of the American Institute of Mining Engineers, the American Malleable Castings association and the Foundry Equipment Manufacturers of the United States in joint meeting assembled,
>
> "That every resource of these allied metal trades is again pledged to the government not only for the production of materials for the conduct of the war, but for the accelerated manufacture of these materials to enable the government to greatly intensify its prosecution of the war and to bring about a speedy and crushing defeat of the enemy that will lead to his abject and unconditional surrender."

Two communications from Edward N. Hurley, chairman, United States Shipping Board, were read by the secretary. These letters follow:

UNITED STATES SHIPPING BOARD
Washington

American Foundrymen's Association,
Cleveland, Ohio.

August 1, 1918.

Gentlemen:

I am going to call upon your organization for some teamwork.

The time has come for Americans everywhere to put themselves solidly behind American ships.

Our railroads must no longer stop at the ocean. We are building an American merchant fleet of twenty-five million tons—three thousand ships. We are backing modern ships with modern port facilities, establishing our bunkering stations all over the globe and will operate with American railroad efficiency. We will carry American cargoes at rates corresponding to our railroad rates—the cheapest in the world. Fast American passenger-and-cargo liners will run regularly to every port in Latin America, the Orient, Africa, Australia.

Are you taking steps to use these ships to increase your own prosperity? Do you realize that American products of factory, farm and mine can be delivered to customers in foreign countries on terms which will build lasting trade?

Do you realize the possibilities for bringing back raw materials to extend your products and trade?

We must all take off our coats and work to bring these American ships home to the people of every American interest and community. The manufacturer must think of customers in Latin America as being as accessible as those in the next state. The farmer must visualize ships carrying his wheat, cotton, breeding animals, dairy products and fruit to new world markets. The American boy must think of ships and foreign countries when he chooses a calling.

Has your organization appointed a live committee on merchant marine?

Is the chairman of this committee a man of international vision?

Are you applying the new world vision to the interests represented in your organization and learning what ships can do toward widening your markets?

These are Your ships. It is your duty to bring them close, regard them as new railroads, spread knowledge about them through investigation, meetings, discussion.

Public neglect ruined our old mercantile marine. Congress was not to blame—it simply reflected the indifference toward ships of the average American. Once more we have a real American merchant fleet under way, backed by far reaching policies for efficient operation. We must dispel indifference and keep our flag on the trade routes of the world. We are going to take trade from no other nation. But we must serve our own customers and help other nations in their ocean transportation problems after the war

I want to hear personally from your organization. These are precious days of opportunity. The nation is united for teamwork and service. Let us "Wake Up, America!"—which means waking up ourselves. I expect you to write me outlining your views and making any suggestions that you think will be helpful in our work.

With personal good wishes, I am,

Yours very sincerely,
(Signed) EDWARD N. HURLEY,
Chairman.

UNITED STATES SHIPPING BOARD
Washington

September 16, 1918.

Mr. A. O. Backert, Secretary-Treasurer,
American Foundrymen's Association,
Cleveland, Ohio.

My Dear Mr. Backert:

I am in receipt of your valued communication of August 13th. I should like very much to be present myself at the combined meeting of the four great organizations representing the metal working industries. However, it is impossible for me to come myself, owing to the many duties which keep me here in Washington and I regret very much indeed to advise you that no plans have been formulated whereby we can send speakers to plead the cause of the American merchant marine.

If you have any further suggestions on this subject, I will be glad to hear from you.

It is time to be thinking about these ships in every American community. I should like to suggest that ships and shipping be discussed in each city, town and village in the United States, from the practical standpoint of what the people make or raise, what they have to sell, how local prosperity can be increased by selling local products to foreign lands.

The very first thing is to become acquainted with our merchant marine as Americans.

Quite a number of business men write and say that they do no foreign trade and think the American merchant marine does not affect them. Or they see no way to back it up because their community is far from the ocean.

There is only one legitimate excuse for not being interested in the American merchant marine—that is—if you were not an American.

The first task is to pull your membership together behind our new ships and begin spreading information about them. The members of your organization should know something about what we are doing; how many ships we are building; how many ships are flying the American flag, and whether we will do foreign business or not.

This is the biggest national improvement that we have ever tackled. Measured in money it represents fifteen times the investment in the Panama canal and measured in time we are doing the job about five times as fast.

It was American understanding and enthusiasm, not selfish interest, that dug the big ditch from Colon to Panama. We must

all get on the job as Americans now and put through the merchant marine because, like the Panama canal, it is the right thing to do for the United States and the world.

The first great task is to organize your Americanism on this issue of the merchant marine and create a healthy, unselfish national curiosity about it. I will supply you with information as fast as it is available and I want you to see that this information not only reaches every member of your organization, but that it is acted upon.

I want you to realize that the American merchant marine is going to take you into a new era. When peace finally comes we must be prepared to put our American spirit and energy at the service of other nations. They will need our money and our tonnage, our ability and team work in developing their resources.

It isn't what we are going to get out of it that counts so much as what we are going to put into it.

I want your committee to read the enclosed Webb act which authorizes combinations for foreign trade. This is an epoch-making law full of wonderful possibilities for team work.

I want you to study foreign countries. Every man, woman and child in this country today should be reading about the peoples and resources, ideals and needs of Latin America, Australia, South Africa, Canada, Mexico, the Orient and Europe.

Every American should turn the pages of American history and inform himself about the achievements of his forefathers on the ocean.

It is time for every business man to become a specialist in the literature of some quarter of the globe.

It is time for American youth to dream dreams of foreign countries and cultivate the natural love of the sea and travel possessed by every healthy boy—and girl.

It is time to study languages—do you know that the Spanish race and tongue today are surpassed in point of numbers, distribution and future promise only by the Anglo-Saxon? Spanish-speaking peoples have a future that will soon surprise the world.

In a little while I will send you lists of good books on such subjects.

I expect to hear from you again and will give your communications my personal attention, for the organizing of true Americanism behind the American merchant marine is one of the most important tasks of the United States shipping board. It would be of little use to build these ships if we could not line every American up behind them.

With personal good wishes, I am,

Yours very sincerely,

(Signed) Edward N. Hurley,

Chairman.

Following the reading of these letters from Mr. Hurley, the resolution committee, by a motion introduced by Alfred E. Howell, Nashville, Tenn., was empowered to draw up an appropriate resolution on the merchant marine for consideration at a later session. These instructions were carried out

and at the concluding session the following resolution was introduced and passed unanimously:

> "*Whereas,* this association has received from Mr. E. N. Hurley, chairman of The United States Shipping Board, a communication suggesting the desirability of this organization taking some recognition of the need of a more general interest upon the subject of an American Merchant Marine, and the inestimable value to the country of an enthusiastic public sentiment favoring revision of laws, making it possible to operate ships in the foreign trade, under the American flag. Therefore be it
>
> "*Resolved,* by the American Foundrymen's association as being in favor of positive patriotic action by the American congress to make it possible for American enterprise and American ship owners to operate with financial success American ships, built by American labor, of American materials and operated by American seamen in order that American commerce may be carried to every port and country on the earth's surface. To arouse and maintain interest in an American Merchant Marine among the members of this association, the president is directed to appoint a committee of five, who with the president and secretary shall devise means for carrying on this work."

The following addresses also were given at the joint opening session:

"Activities of the Army Ordnance Department, Especially as Applied to Foundry Matters," by C. S. Koch, Cannon Section, Production Division, Ordnance Department, Washington, D. C.

"Co-operation Between the Railroad Administration and the Metal-working Industries," by E. D. Brigham, manager iron ore, coal and grain traffic, United States Railroad Administration, Duluth.

"Modern Methods of Transferring Skill," illustrated by military films, by Major Frank B. Gilbreth, Providence, R. I.

Opening Session, American Foundrymen's Association

Tuesday, Oct. 8, 11:30 *a. m., Plankinton Hall*

Benjamin D. Fuller, president, American Foundrymen's association, in the chair. The following addresses and reports were presented.

Annual Address, by Benjamin D. Fuller, president, American Foundrymen's association.

Report of the Board of Directors of the American Foundrymen's Association, Inc.

Report of the Secretary-Treasurer of the American Foundrymen's Association, Inc., by A. O. Backert, Cleveland.

Report of the American Foundrymen's Association Committee on Foundry Costs, by J. Roy Tanner, Pittsburgh Valve, Foundry & Construction Co., Pittsburgh.

President Benjamin D. Fuller announced the appointment of the following convention committees:

Committee on Resolutions.—John A. Penton, chairman, Penton Publishing Co., Cleveland; Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.; W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal, Que.; and C. R. Messinger, Sivyer Steel Casting Co., Milwaukee.

Nominating Committee.—Maj. L. L. Anthes, chairman, Anthes Foundry, Ltd., Toronto, Ont.; A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.; V. E. Minich, Sand Mixing Machine Co., New York; S. T. Johnston, S. Obermayer Co., Chicago; and W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal, Que.

General Session

Wednesday, Oct. 9, 10 a. m., Plankinton Hall

Benjamin D. Fuller, president, American Foundrymen's association, in the chair.

The following papers were read and discussed:

"Selecting Sand-Blast Equipment for the Foundry," by H. D. Gates, Pangborn Corp., Hagerstown, Md.

"Engineers—Their Relation to the Foundry in the Saving of Labor," by E. S. Carman, Cleveland Osborn Mfg. Co., Cleveland.

"Women in the Foundry," by C. E. Knoeppel, C. E. Knoeppel & Co., New York.

"Cottrell Precipitation Process and Its Application to Foundry Dust Problems," by H. D. Egbert, Research Corp., New York.

"The Commerce of Coke," by J. A. Galligan, Pickands, Brown & Co., Chicago.

"Sale and Distribution of Foundry Pig Iron in War Times," by C. J. Stark, editor, *The Iron Trade Review*, Cleveland.

"Ferruginous and Other Bonds in Molding Sands," by Prof. P. G. H. Boswell, Imperial College of Science and Technology, South Kensington, London, Eng.

The report of the nominating committee was unanimously accepted and the following directors were elected for the year 1918-19:

H. R. Atwater, Cleveland Osborn Mfg. Co., Cleveland; R. A. Bull, Duquesne Steel Foundry Co., Coraopolis, Pa.; A. O. Backert, The Penton Publishing Co., Cleveland; W. R. Bean, Eastern Malleable Iron Co., Naugatuck, Conn.; Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I.; H. E. Diller, *The Foundry*, Cleveland; Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.; C. E. Hoyt, Chicago; W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal, Que.; S. T. Johnston, S. Obermayer Co., Chicago; C. S. Koch, Fort Pitt Steel Casting Co., McKeesport, Pa.; W. G. Kranz, National Malleable Castings Co., Cleveland; C. R. Messinger, Sivyer Steel Casting Co., Milwaukee; V. E. Minich, Sand Mixing Machine Co., New York; J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; and H. B. Swan, Cadillac Motor Car Co., Detroit.

Session on Safety and Accident Prevention

Wednesday, Oct. 9, 10 a. m., Juneau Hall

Victor T. Noonan, director of safety, Industrial Commission of Ohio, in the chair.

The following papers and reports were read and discussed:

"Accident Prevention is Good Business," by Fred M. Wilcox, vice president, Industrial Commission of Wisconsin, Madison, Wis.

"The Personal Interest of the Employer is Necessary in Accident Prevention," by Victor T. Noonan.

"The Vital Importance of Industrial Accident Prevention in War Times," by Victor T. Noonan.

"An Accident Prevention Campaign in an Open-Hearth Steel Foundry With the Aid of Safety Committees," by F. G.

Bennett, Director of Safety, Buckeye Steel Castings Co., Columbus, O.

"Safety and Efficiency, Facts and Figures," by C. W. Price, field secretary, National Safety Council, Chicago.

Report of the American Foundrymen's Association Committee on Safety, Sanitation and Fire Prevention, by Victor T. Noonan, chairman. This report was unanimously accepted. The fire prevention regulations, which were tentatively submitted, were referred back to the committee for final completion and report at the 1919 convention.

Gray Iron Session

Thursday, Oct. 10, 10 a. m., Plankinton Hall

Benjamin D. Fuller, president, American Foundrymen's association, in the chair.

The following papers were read and discussed:

"The Continuous Two-Story Foundry," by J. F. Ervin, Michigan Motor Castings Operating Co., Flint, Mich.

"Organizing a Foundry for the Economical Production of Gray Iron Castings," by Paul R. Ramp, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.

"The Use of Positive Displacement Blowers in Cupola Practice," by W. Trinks, Carnegie Institute of Technology, Pittsburgh.

"Recent Developments in Burning Oil in Cupolas," by John Howe Hall, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

"A Rapid Method for the Determination of Graphitic Carbon," by Frank H. Kingdon, Sullivan Machinery Co., Claremont, N. H.

Report of the A. F. A. Committee on General Specifications for Gray Iron Castings, by Richard Moldenke, Watchung, N. J. This report was accepted.

Malleable Session

Thursday, Oct. 10, 10 a. m., Engelman Hall

J. P. Pero, past president, American Foundrymen's association, in the chair.

The following papers and reports were read and discussed:

"Malleable Iron as a Material in Engineering Construction," by H. A. Schwartz, National Malleable Castings Co., Indianapolis, Ind.

"Experiments in Annealing Malleable Iron," by H. E. Diller, *The Foundry,* Cleveland.

"A Modern Core Room," by Donald S. Barrows, T. H. Symington Co., Rochester, N. Y.

"Some Factors in the Manufacture of High Grade Iron Castings," by J. G. Garrard, Northwestern Malleable Iron Co., Milwaukee.

"The Integrity of the Casting," by Enrique Touceda, consulting engineer, Albany, N. Y.

"Advantages of Malleable Iron Versus Steel for Agricultural Castings," by P. A. Paulson, Rockford Malleable Iron Co., Rockford, Ill.

"Annealing Malleable Iron," by R. S. Archer and Maj. A. E. White.

Report of the A. F. A. Committee on Specifications for Malleable Iron Castings, by Enrique Touceda, Albany, N. Y. This report was accepted.

Steel Session

Thursday, Oct. 10, 10 *a. m., Committee Room A.*

C. R. Messinger, director of the American Foundrymen's association, in the chair.

The following papers were read and discussed:

"Ordnance Steel for the Army and Navy," by John Howe Hall, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

"Meeting Specifications for Army Ordnance Steel Castings," by Capt. E. R. Swanson, Ordnance Department, Inspection Division, Washington, D. C.

"Making Steel Castings on the Pacific Coast," by J. D. Fenstermacher, Columbia Steel Co., San Francisco.

"The Electric Furnace in the Steel Foundry," by W. E. Moore, W. E. Moore & Co., Pittsburgh.

"The Advantages of the Basic Lining for Electric Furnaces," by J. F. Ryan, Electric Furnace Construction Co., Philadelphia.

Report of the Committee on Steel Foundry Standards, by W. A. Janssen, chairman, Canadian Steel Foundries, Ltd., Montreal, Que. This report was accepted.

Semisteel Shell Session

Thursday, Oct. 10, 2 *p. m., Plankinton Hall*

John A. Penton, honorary member, American Foundrymen's association, in the chair.

At this session the problems involved in manufacturing semisteel shells were presented by means of addresses by American and French experts followed by informal discussions.

Following introductory remarks by the chairman, the technical features of cast semisteel shell manufacture, from the standpoint of the army, were discussed by Capt. H. M. Huxley, engineering division, Ordnance Department, Washington. The French Technical Mission was represented at the meeting by Capt. Guillemin and Lieutenants Laurent and Blanchet. Lieutenant Laurent made a prepared address dealing with the metallurgy of semisteel shell, based on French military experience. F. B. Howell, head of the research department of the American Radiator Co., gave an address on American semisteel shell manufacture from the foundry standpoint, illustrated by lantern slides. This address was based on experiments made by the American Radiator Co. and on the work of the government's semisteel shell committee on manufacturing practice of which John A. Penton was chairman.

Final Professional and Business Session

Friday, Oct. 11, 10 *a. m., Plankinton Hall*

Benjamin D. Fuller, president of the American Foundrymen's association, in the chair.

The following papers were read and discussed:

"Effective Means of Improving the Quality of Foundry Sand Mixtures," by Henry B. Hanley, New London Ship & Engine Co., Groton, Conn.

"How Cost and Inspection Data are Secured in the Foundry of the Naval Gun Factory," by Lieut. Walter S. Doxsey, U. S. Navy Yard, Washington, D. C.

"Pyrometers and Their Application to Core Ovens," by G. W. Keller, Brown Instrument Co., Philadelphia.

"Concrete Foundry Floors," by George Moyer, Textile Machine Works, Reading, Pa.

"A Pouring Device for Modern Foundries," by Mark P. Ohlsen, Brillion Iron Works, Brillion, Wis.

"Suggestions on Machining Semisteel Shells," by a representative of the Ordnance Department.

Report of the A. F. A. Committee advisory to the United States Bureau of Standards, by Richard Moldenke, Watchung, N. J. This report was accepted.

Announcement was made of the election of officers of the American Foundrymen's association to serve for the ensuing year as follows:

President.—A. O. Backert, Penton Publishing Co., Cleveland.

Vice President.—W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal, Que.

Secretary-Treasurer.—C. E. Hoyt, Harris Trust Building. Chicago.

The following resolutions, prepared by the Committee on Resolutions, were presented and unanimously adopted:

W. J. Keep

"*Whereas* the convention of the American Foundrymen's Association, assembled in Milwaukee, has heard of the accidental and sudden death of Mr. William J. Keep, of Detroit, Mich., and

"*Whereas* Mr. Keep was one of the leading spirits in the formation of this association and contributed a great volume of useful technical knowledge to its members through papers

and publications that have been of incalculable value to the foundry industry and recognized as such, not only in America, but in Europe and in all foreign countries where the industry is practiced, therefore

"*Be it resolved,* that the American Foundrymen's association record its sorrow and deep regret, and direct that a copy of this resolution be conveyed to his family with the sincere sympathy of this organization."

S. Griswold Flagg III

"*Whereas* Mr. S. Griswold Flagg III, our valued and esteemed Vice President, moved by his keen sense of patriotism, has embarked in the service of our government, necessitating the cessation of his activities as an officer of the association,

"*Be it resolved,* that the American Foundrymen's association communicate to Mr. Flagg its sincere regret at losing his presence and counsel, but applaud his fine spirit, and wish for his happy return, and that this communication be duly transmitted to him with our esteem and regard and God-speed."

Resolution of Thanks

"*Whereas,* this convention of the American Foundrymen's association in allied congress assembled with the Iron and Steel and Metals divisions of the American Institute of Mining Engineers and the American Malleable Castings association, is the most successful in its history, and

"*Whereas,* this successful convention in a large measure is due and attributable to the activity and sincere interest of those who have labored unceasingly in the reception and entertainment of the large number of visitors, and

"*Whereas,* the technical program unprecedented in number and excellence of papers as presented by recognized industrial experts and by representatives of the allied armies on a variety of subjects of particular interest to the gray and malleable iron and cast steel foundrymen for the successful furtherance of his trade in times of peace and aiding in the successful prosecution of the war, therefore be it

"*Resolved,* that the members of the American Foundrymen's association extend their deep appreciation and hearty thanks to the Milwaukee Chamber of Commerce and the members committee of that organization and the local Foundrymen's committees which made possible this convention and who made our visit to the city of Milwaukee so pleasant and enjoyable and whose hospitality was without bounds; to the management of the Auditorium, to the authors and speakers who contributed to our program, to the daily press of Milwaukee, the trade press of the country, and all others who in any way contributed to the wonderful success of this the twenty-third annual meeting of our organization."

Upon motion of Alfred E. Howell, the retiring president, Benjamin D. Fuller was unanimously elected an honorary member of the American Foundrymen's association.

Following the installation of the newly-elected officers of the American Foundrymen's association, the proceedings of the twenty-third annual convention were unanimously approved.

There being no further business, the meeting adjourned.

Annual Banquet

Thursday, Oct. 10, *7 p. m., Milwaukee Auditorium*

Theodore O. Vilter, Vilter Mfg. Co., Milwaukee, presided.

The following addresses were delivered:

"A Glimpse of the Western Front," by Maj. A. Radclyffe Dugmore of the British army; "The Hog Island Shipyard," by W. H. Blood Jr., assistant to the president, American International Shipbuilding Corp.; and "America's War Efforts," by Charles M. Schwab, director-general, United States Emergency Fleet corporation, Philadelphia.

Entertainment Features

Headed by Theodore O. Vilter, chairman of the executive committee, the various local entertainment committees provided several enjoyable occasions. Tuesday afternoon automobiles were furnished the visiting ladies by Milwaukee citizens and the guests were conducted on a tour in and about the city. Tuesday evening a reception and dance was held in one of the spacious halls of the auditorium. Wednesday noon, the ladies were tendered a luncheon and Wednesday night, the entire Majestic vaudeville theater was reserved for the visiting delegates and their guests. Thursday afternoon completed the schedule of entertainment provided by the local committee, when a card party and tea was held in the Badger room of the Hotel Wisconsin. According to the custom of the past years, the ladies attended the annual banquet. Special plant visitation excursions, which included a large number of prominent foundries and industrial establishments in Milwaukee and vicinity, were organized on Thursday and Friday, Oct. 10 and 11.

Benj. D. Fuller

Benjamin D. Fuller

President American Foundrymen's Association, 1917-1918

Benjamin Delano Fuller, the nineteenth president of the American Foundrymen's association, was born in South Scituate, Mass., Feb. 10, 1864. He served eight years as apprentice and journeyman molder for the Pittsburgh Locomotive Works, two years with Mackintosh, Hemphill & Co. in their steel foundry, and in 1890 joined the Westinghouse interests. He was successively assistant foreman, foreman, general foreman and assistant superintendent. When the company established its large foundries at Cleveland, Mr. Fuller was made superintendent of foundries in charge of both the Cleveland and Allegheny City plants. He rapidly built up an efficient organization, established a malleable foundry, and during the war produced successfully millions of rifle grenades. He resigned in October, 1918, to become vice president and general manager of the Niagara Electric Furnace Co., Niagara Falls, N. Y.

He is a past president of the Pittsburgh Foundrymen's association; member of the subcommittee on iron and steel scrap of the American Iron and Steel institute, war service committee; member of the foundry committee of the American Society of Mechanical Engineers, and the cast scrap committee of the American Society for Testing Materials.

Transactions of the American Foundrymen's Association

Annual Address

By the President, Benjamin D. Fuller

IT is with a full appreciation of the honor conferred upon me that I address you at the opening of this great convention. The honor of being President of this body is to me the crowning satisfaction of my career as it was conferred by those with whom my lot was cast when a boy, and association with men comprising the membership of the American Foundrymen's association will ever be the dearest of memories. The past year has been so rife and so tingling with events vital to our very existence that it is beyond my limited powers to impress upon you the importance of what has been and is being done daily in our great country. President Wilson on July 4 said at Mt. Vernon, "It is the Past and Present in deadly grapple and the people of the earth are being done to death between them. But there *can* be but *one* issue." The confiding optimistic spirit of a liberty-loving humanity has been suddenly and ruthlessly aroused to the realization that liberty is threatened, and the power dormant for long is now gathering such impetus that it is as resistless as God's lightning and will prove as destructive to the assailing disciples of Dark Ages. Politics, isms and creeds have been forgotten. The response to the call has been inspiring, the achievements nothing short of wonderful.

The foundry interests of the country have taken their place among the leaders in the work of producing vitally needed material. Steel foundries have been particularly busy with armament, while the gray iron and malleable plants have been called upon to produce trench mortars, shells, hand and rifle grenades, etc. Aluminum and nonferrous foundries have

to do with airplane and motor work. In many cases this entailed a transformation in shop equipment and shop practice which has been brought about quickly and cheerfully.

The sudden extraordinary demand for fuel and metal created by the government program and the response of the manufacturing interests has caused a pronounced shortage in iron which in turn has made it imperative that the government assume control and allot to the plants carrying on work essential to this program their requirements. This has, in many cases, affected the manufacturers of nonessentials until such times as a readjustment may be brought about.

In the train of events and following closely this increase in capacity the iron foundrymen in certain lines have been confronted with a classification of their products as more or less nonessential with the result that many have been compelled to adopt a change of method, venturing into new lines of work, entailing expense in equipment, while others have temporarily closed pending developments; this is particularly true of the stove and hardware manufacturers. It is quite an undertaking to jump from the casting of stoves to the casting of shells, but this has been done by some and we will in all probability see many others follow.

The curtailing of pig-iron shipments to those whose business comes within the category of nonessential industries has been a leading factor in the slowing-up of many foundries, with no immediate relief from increased shipments in sight.

Furnaces furnishing iron to foundries have been called upon to hold up deliveries of foundry iron and turn to production of steelmaking pig and while this has caused foundrymen to readjust and has more or less unsettled general business, the wonderful achievements of our government during the past year makes the inconveniences fade into insignificance.

The installation of foundry equipment and modernizing of methods has been tremendously accelerated. Manpower has responded to the call and the production secured by the combination of willing men and modern machinery has been in many cases fairly astounding.

The advance in quality of products also has been notable in many instances. For example, the development of the cast-

steel anchor chain, a foundry product showing astonishing results under test. Electric and open-hearth furnaces both show improvement in results. Cupola operation is also coming in for closer study, the introduction of oil for fuel being one of the promising innovations in this connection. Alloys are now successfully produced in cupola practice for mixtures which a few years ago were made entirely by the crucible furnace process.

Coke Conservation Urged

I would urge the conservation of coke as worthy of our earnest consideration and while it is not wise to save in the furnace to the extent of losing through poor product, there is much useless waste in cupola practice and close attention to quality of material, upkeep of equipment, regulation of blast and conservative charging will show a handsome saving in many cases. By-product coke is being manufactured to a greater extent than ever before. In the purchase of coke I would recommend adding to the specifications a clause defining the minimum size, or, in other words, that the foundry be furnished a screened material. Much inferior coke has been delivered, one of the chief defects being the large proportion of fines or breeze.

Coke Director Blauvelt has recognized this in recommending that coke shippers be penalized to the extent of $1.00 per ton for shipments of inferior material, a recommendation which would meet with hearty approval and support.

Real Co-operation

Our government in its endeavor to standardize many essential products, has touched the foundry industry in stoves and furnaces. Reducing styles and sizes in this industry, as in others, will effect great economies. A development which has been of peculiar interest is the changing from malleable to cast iron in the manufacture of hand grenades for the government, the change being made with a view to the safety of our troops. The change coming suddenly, was brought about quickly and with but slight disturbance to the industry, furnishing one more instance of the earnestness of the co-operation between the government and the manufacturer.

Of interest and promise to our industry is the adoption by the government of the semisteel shell. Experiments with cast shells seemingly have been sufficiently gratifying to warrant the government in specifying a liberal production and the prophecy that this will take an important place in the industry. Standard methods of producing a satisfactory product are being earnestly studied and should be of assistance to all. The production of semisteel shells promises also to be of interest to the malleable founder as the air furnace is seemingly the ideal unit for producing a high grade and uniform material.

At the Boston convention, last year, the American Foundrymen's Association recommended to Secretary of War Baker the advisability of sending to France a selected committee of foundrymen for the purpose of studying methods of semisteel shell and ordnance manufacture. In view of the present call for semisteel production I am very sorry that this recommendation was not acted upon, General Crozier, to whom it was referred, not approving.

French Data Would Be Valuable

The difficulties in the way of successful production of these shells are by no means slight. Had the foundrymen been afforded the opportunity of acquiring first-hand knowledge of the French methods through a representative committee I feel it would have proved of great assistance today. It is true that there have been advancements in methods in some instances, but in general, the foundrymen are ignorant to a degree of what is entailed in the successful production of these shells and grief will result from attacking the proposition blindly.

The production of grenades during the past year has been large. Much credit is due foundrymen for the manner in which shops have turned from lines very different to the successful production of grenade castings. The rifle grenade, made of malleable iron, calls for a casting soft enough to be easily machined and of tough composition, clean and sound with the cores centrally located, etc.

Such devices as multiple core boxes, ingenious arrangement of core plates, devices for turning out and handling dry

cores, molding machines, short cut methods of ramming and venting, etc., have brought about an average production in some shops of 1600 to 1700 castings per machine molder per day, with 1200 to 1400 cores per day from each girl; men being used at the molding machines and girls for coremaking.

That our industry has been called upon to play an important part in the great industrial movement is demonstrated by statistics showing its growth. On Aug. 1, 1918, there were 5898 iron, steel, brass and malleable iron foundries in the United States as compared with 5741 in 1916, a gain of 157. The total number of gray iron foundries in 1918 was 4326 as compared with 4267 in 1916. The number of malleable iron foundries in 1918 was 249 as compared with 197 in 1916. The growth in the number of malleable iron shops has been enormous. In 1918 there were 390 steel foundries as compared with 304 in 1916, representing a gain of 86. It is interesting to note also that 143 of these steel foundries were making steel by the electric process on Aug. 1, 1918. Unfortunately, we have no figures showing the number of foundries melting by the electric process in 1916. The production of alloys by the electric furnace process has been stimulated and promises further development.

Milwaukee—Sixth Foundry Center

In this connection it also will be of interest to note that Milwaukee ranks sixth in number of foundries in the United States with a total of 94 as compared with 69 in 1916. In total number of foundries, Chicago is first with 188; New York second with 125; Cleveland third with 115; Philadelphia and Detroit are tied for fourth and fifth places, respectively, with 111, and Milwaukee is sixth with 94.

Our Association has been active and has been in close touch with the government. That the service rendered has been thoroughly appreciated I can assure you. Your directors, secretary and manager of the war service work will furnish interesting reports of our activities.

One year ago at Boston the American Foundrymen's Association, realizing that we were in a position to be of assistance to our government in formulating its war program, authorized

the appointment of a War Service Board to co-operate with the government in the placing of contracts for castings, preparing of specifications and rendering such other service as might be found necessary. Accordingly a board was formed of representative men of the cast iron, steel, malleable and nonferrous branches of the foundry industry. Offices were established in Washington with our capable director, C. E. Hoyt, in charge, and for a period of six months the board rendered exceedingly valuable assistance to various governmental departments. Being immediately acquainted with our industry our efforts were of value and highly appreciated for the reason that we were actuated solely by patriotic motives in contrast to many so-called war service committees camping in the capital city for the sole purpose of obtaining contracts for members of the organizations which they represented. Our board sought only to aid by giving advice regarding equipment of foundries, ability to produce, preparing of specifications, etc. In view of their previous experience, it required time for the various department heads to recognize the true attitude of your committee, but when its purpose became known it was made welcome and pressure was brought to bear to prevent discontinuing its activities when the Washington office was closed on July 1. The committee made an exhaustive survey of the entire industry of the United States for the purpose of ascertaining capacities, equipment, shop conditions, etc. The pig iron situation was investigated and the recommendations made resulted in more foundry iron being available than would otherwise have been the case had the plan to divert very large tonnages to steelmaking grades been carried out. Supported by the funds of this organization, having "no axe to grind", the work was carried out in the spirit of its conception and you are to be congratulated on the results obtained. The pride I feel in having been your President is justified by the position we have attained.

We can look to the future with great confidence as strict adherence to the policy we have always pursued, the policy of helpfulness to our industry in an educational and advisory way, will be productive of even greater results in the future than during the past.

Annual Report of the Board of Directors

To the Members of the American Foundrymen's Association, Inc.:—

Two meetings of the Board of Directors of the American Foundrymen's Association, Inc., were held during the fiscal year, one at Boston, principally for the purpose of organizing and electing officers, and the other at Pittsburgh, Saturday, Feb. 16, 1918.

At the Boston meeting, held Thursday, Sept. 27, 1917, in Paul Revere hall, it was decided to appoint an executive committee to transact the business of the board in the interim between meetings of the Board of Directors. This was done to effect economies in traveling expenses, etc.

At the meeting of the Board, held at Pittsburgh, Saturday, Feb. 16, 1918, a report of an informal meeting of the executive board, held Friday, Dec. 21, 1917, at Pittsburgh, was presented. At this meeting arrangements were made for establishing an office at Washington by the War Service Committee and C. E. Hoyt, Chicago, was elected secretary to have charge of the Washington activities. Major R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh, was elected chairman and the other members of this committee consisted of the following: H. D. Miles, Buffalo Foundry & Machine Co., Buffalo; G. H. Clamer, Ajax Metal Co., Philadelphia; Ralph H. West, West Steel Casting Co., Cleveland, and J. C. Haswell, Dayton Malleable Iron Co., Dayton, O. Subsequently, Major R. A. Bull was called into service and was compelled to resign from the committee and H. D. Miles was elected to succeed him as chairman.

At this meeting, C. E. Hoyt, Chicago, also was employed by the American Foundrymen's Association at a fixed salary to devote all of his time to the affairs of this organization and to perform such duties as may be assigned to him from time to

time. At this meeting it also was decided to continue in good standing all members of the Association who might be called into active service. During this period their dues will be suspended and they will retain all of the privileges of membership including the receipt of all publications, if active members, and of the pamphlets, if associates. Major Bull also tendered his resignation from the Board of Directors of the association, but this was not accepted.

S. Griswold Flagg, 3d, who was elected vice president of the association to serve during the 1917-1918 term, tendered his resignation, having been commissioned a naval constructor with the rank of Lieutenant, Senior Grade, U. S. N. R. F. He has been called to active service at the Naval Aircraft Factory, League Island Navy Yard, Philadelphia, where he has been appointed assistant general superintendent and placed in charge of Aircraft Factory, No. 1. Lieut. Flagg stated that it would be impossible for him to continue his official affiliation with the American Foundrymen's Association and his resignation was accepted reluctantly by President Benj. D. Fuller. Inasmuch as his term of office was within a few months of expiration, President Fuller decided to leave the office vacant.

Only one meeting of the Exhibition Committee of the American Foundrymen's Association, Inc., was held during the year, namely, at the William Penn Hotel, Pittsburgh, Saturday, Feb. 16, 1918. At this meeting the report of C. E. Hoyt, exhibition manager, in charge of the Boston exhibition, was received and preparations were made for the 1918 exhibition. A special committee also was appointed for the purpose of selecting the time and place of the 1918 convention and this committee met at Milwaukee, Monday and Tuesday, Feb. 25 and 26, 1918, when the invitation from that city was accepted.

The report of the various meetings of the Board of Directors, Exhibition Committee, etc., are appended herewith.

Respectfully submitted,

A. O. Backert, Secretary.

Minutes of Meeting of the Board of Directors

ANNUAL MEETING OF THE BOARD OF DIRECTORS OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION, INC., THE COPLEY PLAZA HOTEL, BOSTON, SEPT. 23, 1917

Pursuant to a call for the annual meeting of the Board of Directors of the American Foundrymen's Association, Inc., issued by President J. P. Pero, Missouri Malleable Iron Co., E. St. Louis, Ill., a meeting of the Board was held at the Copley-Plaza Hotel, Boston, Sept. 23. However, in the absence of a quorum the meeting was adjourned and the president immediately called another meeting to be held in Paul Revere Hall, Mechanics building, Thursday, Sept. 27.

J. P. PERO, Chairman.
A. O. BACKERT, Secretary.

ANNUAL MEETING OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION, INC., HELD IN PAUL REVERE HALL, MECHANICS BUILDING, BOSTON, WEDNESDAY, SEPT. 26, 1917

The annual meeting of the members of the American Foundrymen's Association, Inc., was held in Paul Revere Hall, Mechanics building, Boston, Wednesday, Sept. 26. President J. P. Pero announced the presence of a quorum and called for the report of the Nominating Committee appointed at the first session of the annual meeting, Monday afternoon, Sept. 24. This committee consisted of the following:

R. A. Bull, chairman, Duquesne Steel Foundry Co., Pittsburgh.
A. W. Walker, Walker & Pratt Mfg. Co., Boston.
W. H. McFadden, Ponca City, Okla.
A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
S. T. Johnston, S. Obermayer Co., Chicago.
A. B. Root Jr., Hunt-Spiller Mfg. Corp., Boston.
Stanley G. Flagg Jr., Stanley G. Flagg & Co., Philadelphia.

J. P. Pero, President of the Association, was in the chair. The report of the nominating committee submitted the following names of persons to serve as directors for the year 1917-1918:

H. R. Atwater, Cleveland Osborn Mfg. Co., Cleveland.
A. O. Backert, Penton Publishing Co., Cleveland.
R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh.
H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
H. E. Diller, General Electric Co., Erie, Pa.
S. Griswold Flagg 3d, Stanley G. Flagg & Co., Philadelphia.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
C. E. Hoyt, Chicago.
W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal.
S. T. Johnston, S. Obermayer Co., Chicago.
J. F. Kent, American Cast Iron Pipe Co., Birmingham, Ala.

V. E. Minich, Sand Mixing Machine Co., New York.
J. P. Pero, Missouri Malleable Iron Co., E. St. Louis, Ill.
Jos. T. Speer, Pittsburgh Valve Foundry & Const. Co., Pittsburgh.
H. B. Swan, Cadillac Motor Car Co., Detroit.

In submitting his report R. A. Bull, chairman of this committee, directed attention to the by-laws, which provide for the election of 16 directors to be elected from and by the active and honorary members of the association. Motion was made and seconded that the persons nominated be elected members of the Board of Directors of the American Foundrymen's Association, Inc., and the foregoing list nominated was elected unanimously.

At the meeting held Monday afternoon, Sept. 24, in Paul Revere Hall, the annual reports of the Board of Directors and the Secretary-Treasurer were submitted and adopted unanimously.

The annual meeting of the Association was adjourned Friday noon, Sept. 28.

J. P. Pero, President.
A. O. Backert, Secretary.

Meeting of the Board of Directors of the American Foundrymen's Association, Inc., Paul Revere Hall, Mechanics Building, Boston, Thursday, Sept. 27, 1917.

Following the session of the annual meeting of the American Foundrymen's Association, Inc., held Wednesday, Sept. 26, at which members of the Board of Directors were elected, a meeting of the members of this board was held in Paul Revere Hall, Mechanics building, Boston, Thursday, Sept. 27, for the purpose of electing officers and transacting such other business as might be presented.

At the session of the annual meeting, held Wednesday, Sept. 26, the following were elected members of the Board of Directors of the American Foundrymen's Association, Inc.:

H. R. Atwater, Cleveland Osborn Mfg. Co., Cleveland.
A. O. Backert, Penton Publishing Co., Cleveland.
R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh.
H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
H. E. Diller, General Electric Co., Erie, Pa.
S. Griswold Flagg 3d, Stanley G. Flagg & Co., Philadelphia.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
C. E. Hoyt, Chicago.
W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal.
S. T. Johnston, S. Obermayer Co., Chicago.
J. F. Kent, American Cast Iron Pipe Co., Birmingham, Ala.
V. E. Minich, Sand Mixing Machine Co., New York.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
Jos. T. Speer, Pittsburgh Valve Foundry & Const. Co., Pittsburgh.
H. B. Swan Cadillac Motor Car Co., Detroit.

The following members of the Board were in attendance: J. P. Pero, A. E. Howell, B. D. Fuller, V. E. Minich, S. T. Johnston, R. A. Bull, H. E. Diller, C. E. Hoyt and A. O. Backert. W. H. McFadden, Ponca City, Okla., a member of the Advisory Board, also was in attendance. Mr. J. P. Pero, president, was in the chair.

Nominations for the office of president of the American Foundrymen's Association were called for and A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn., nominated B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland, for this office; his nomination was seconded by V. E. Minich and R. A. Bull. Motion was made that the nominations be closed, which prevailed unanimously.

Nominations for the office of vice president of the American Foundrymen's Association then were called for and R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh, placed in nomination S. Griswold Flagg 3d, Stanley G. Flagg & Co., Philadelphia; Mr. Flagg's nomination was seconded by A. E. Howell. A motion then was made that the nominations be closed and this prevailed unanimously.

Nominations for the office of secretary and treasurer were then called for and a motion was made by C. E. Hoyt and seconded by A. E. Howell that the office of secretary and treasurer be combined. This motion prevailed without dissent. C. E. Hoyt, of Chicago, then nominated A. O. Backert, Cleveland, for the combined office of secretary-treasurer and this was seconded by A. E. Howell. Motion then was made that the nominations be closed and this prevailed unanimously.

It was then moved and seconded that the secretary cast the ballot for the election of the above named gentlemen for the offices of President, Vice President and Secretary-Treasurer and the ballot was so cast. The officers of the American Foundrymen's Association, Inc., for the year 1917-1918, as elected, follow:

President:—B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.

Vice President:—S. Griswold Flagg 3d, Stanley G. Flagg & Co., Philadelphia.

Secretary-Treasurer:—A. O. Backert, Cleveland.

It was moved by C. E. Hoyt and seconded by R. A. Bull that the Secretary-Treasurer of the American Foundrymen's Association be paid a salary of $1800 per annum, payable in 12 monthly installments of $150.00 each. This motion prevailed without dissent.

It was suggested that an Executive Committee of the Board of Directors be appointed to transact business of the Board in the interim between meetings of the Board of Directors of the American Foundrymen's Association, Inc. Motion was made by A. E. Howell and seconded by S. T. Johnston, that a committee of five (5) be appointed to consist of the three officers of the association and two (2) others. After a brief discussion this motion was adopted.

For the purpose of selecting the time and place of the 1918 convention and exhibition of the American Foundrymen's Association, Inc., A. E. Howell presented a motion which was seconded by R. A. Bull, that this be left in the hands of a committee consisting of the officers of the Association and the exhibition manager.

This motion prevailed without dissent.

The newly elected president, Mr. B. D. Fuller, then announced that he would appoint the other two members of the Executive Committee within the next 30 days.

There being no further business the meeting adjourned.

J. P. Pero, President.
A. O. Backert, Secretary.

Meeting of the Board of Directors of the American Foundrymen's Association, Inc., Held at the William Penn Hotel, Pittsburgh, Saturday, Feb. 16, 1918.

A meeting of the Board of Directors of the American Foundrymen's Association, Inc., was held at the William Penn Hotel, Pittsburgh, Saturday, Feb. 16, 1918.

The following were in attendance:

H. R. Atwater, Cleveland Osborn Mfg. Co., Cleveland.
A. O. Backert, Penton Publishing Co., Cleveland.
H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
H. E. Diller, General Electric Co., Erie, Pa.
B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
C. E. Hoyt, Chicago.
W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal, Que.
S. T. Johnston, S. Obermayer Co., Chicago.
V. E. Minich, Sand Mixing Machine Co., New York.
J. P. Pero, Missouri Malleable Iron Co., E. St. Louis, Ill
Major Jos. T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
H. B. Swan, Cadillac Motor Car Co., Detroit.

The only absentees were Major R. A. Bull, Vice President S. Griswold Flagg 3d and J. F. Kent.

In the absence of President Benj. D. Fuller, H. A. Carpenter presided temporarily. However, after the meeting had been in session about 30 minutes, President Fuller arrived and he presided throughout the remainder of the session.

The secretary presented a report of an informal meeting of four of the directors of the Association which was held at the William Penn Hotel, Pittsburgh, Friday, Dec. 21, 1917. This meeting was attended by Benj. D. Fuller, president; A. O. Backert, secretary-treasurer; Major R. A. Bull, chairman of the War Service Committee and C. E. Hoyt, exhibition manager. Major Bull pointed out the necessity of employing a secretary to carry on this work at Washington and President Fuller thereupon appointed C. E. Hoyt, of Chicago, to this office. Major Bull announced that he had rented two rooms as headquarters for this War Service Committee in the National Union building, 918 F street N. W., Washington, D. C., at a rental of $27.50 per month, subject to ratification by the Board of Directors.

President Fuller arranged for the employment of C. E. Hoyt by the American Foundrymen's Association, Incorporated, at a salary of $600.00 per month. Mr. Hoyt is to devote all of his

time to the affairs of this organization and is to perform such duties as he may be called upon to assume from time to time. In view of the fact that Mr. Hoyt will be assigned the conduct of the 1918 exhibition, it was recommended by President Fuller that his salary be distributed on the following basis: Four hundred dollars per month to be charged to the Exhibition Account and $200.00 per month to the Technical Account, dating from Dec. 15, 1917.

After a brief discussion, A. E. Howell recommended the ratification on this action and it was seconded by Major Jos. T. Speer; this motion was unanimously approved.

C. E. Hoyt, manager of the 1917 exhibition of the American Foundrymen's Association held at Boston, presented an audit of the finances of this event made by Ernst & Ernst, expert accountants. An audit committee of the Association was appointed by the President to consider this report with instructions to report its findings at the afternoon session. This committee consisted of Messrs. Minich and Pero.

A report of the activities of the War Service Committee then was requested and C. E. Hoyt, Secretary, briefly outlined the work that is being done at Washington. He stated that the committee as originally appointed by President Fuller consisted of Major R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh, chairman; H. D. Miles, Buffalo Foundry & Machine Co., Buffalo, vice chairman; Major C. C. Smith, Union Steel Castings Co., Pittsburgh; J. C. Haswell, Dayton Malleable Iron Co., Dayton, O., and G. H. Clamer, Ajax Metal Co., Philadelphia. However, after this committee held its first meeting at Washington, Major R. A. Bull was compelled to resign as chairman, having been called for active service, and Major C. C. Smith was compelled to resign owing to the fact that he had accepted a commission as Major in the Officers' Reserve Corps with an assignment to the ordnance Department. H. D. Miles thereupon was appointed chairman of the committee and Ralph D. West, West Steel Casting Co., Cleveland, was appointed to fill one of the vacancies. However, one vacancy has not yet been filled and it was decided in the interim to proceed with the outlined work of the committee. Mr. Hoyt stated that of all of the committees representing various industries at Washington, the War Service Committee of the American Foundrymen's Association, Inc., had received a greater amount of recognition by the government than any other. Officers of the Ordnance Department have frequently called upon the committee for suggestions, advice and information and Mr. Hoyt was of the opinion that the work of this committee should be continued.

The cost of conducting the work of this committee with offices at Washington was estimated at about $800.00 per month. Mr. Hoyt stated further that a survey of the foundry industry of the United States was being made, questionnaires having been sent to all of the casting plants of the United States and the information thus obtained will be compiled for the use of the various governmental departments.

The question of financing the work of this committee also received careful consideration by the Board. It was pointed out that in view of the necessity of retaining ample funds in the treasury for the purpose of financing the 1918 exhibition, it was desirable to know how the work of the committee may be financed after the funds available have been exhausted.

A motion was offered by H. A. Carpenter, which was seconded by S. T. Johnston, which provided for the receipt of Mr. Hoyt's report as progressive and the officers of the Association are to be instructed to decide within the next 60 or 90 days whether it is desirable to continue or to terminate the work of the War Service Committee. Also, the question of raising additional funds is to be left to the discretion of the committee. It previously had been recommended that funds for defraying the expenses of this work be raised by contribution among foundrymen of the United States. The motion as offered by Mr. Carpenter and seconded by Mr. Johnston was ratified without dissent.

It was reported by the secretary that a number of the members of the Association had entered the active military service of the government and had tendered their resignations from the Association. However, upon instruction by President Fuller and subject to ratification by the Board of Directors, the secretary was requested to advise such members that they would be continued as members in good standing until the approval or disapproval of the action of the president had been received from the Board of Directors.

It was moved by A. E. Howell and seconded by H. A. Carpenter that all members of the association who enter the active military service of the Government will have dues suspended during the period of such service and that while in such service such members will retain all of the privileges of the association, including the receipt of all of the publications if they are active members and of the pamphlets only, if associate members. This motion prevailed without dissent.

President Fuller announced that he had received the resignation of Major R. A. Bull from membership on the Board of Directors, but that he refused to accept it. H. A. Carpenter offered a motion ratifying the action of the president, which was seconded by A. E. Howell and was carried unanimously. The secretary then was instructed to send a telegram to Major R. A. Bull to be signed by all of the members of the Board in attendance and which was as follows:

Major R. A. Bull,
Blackhawk Hotel,
Davenport, Iowa.

"A. F. A. directors assembled have read your letters to Fuller and Minich, enjoyed and appreciated them. Unanimously commend our president in declining to entertain your withdrawal from the board. Your lucubrations on Kaiser read and reread and toasted. To you we turn down an empty glass. Mrs. Bull here to dinner. All delight to honor her. Cheero from all of us."

H. R. Atwater, A. O. Backert, H. A. Carpenter, H. E. Diller, B. D. Fuller, A. E. Howell, C. E. Hoyt, W. A. Janssen, S. T. Johnston, V. E. Minich, J. P. Pero, Jos. T. Speer and H. B. Swan.

At a meeting of the Cost Committee of the American Foundrymen's Association, Inc., it was recommended that the board of directors of the association consider the advisability of accepting subscriptions from nonmembers of the organization to cover the cost of participation in the cost work and in the cost system compiled for the association by C. E. Knoeppel & Co. This recommendation was discussed at length and it was the concensus of opinion that nonmembers of the organization should not derive

the benefits of this effort on the same basis as members. Thereupon, a resolution was offered by A. E. Howell and duly seconded by W. A. Janssen that an additional charge of $25.00 be made to nonmembers of the association for subscriptions to this work. This provides for a minimum initial charge of $75.00 and a maximum charge of $275.00 with an intermediate charge of $25.00 greater than that made to members of the association. This resolution was ratified unanimously.

This motion also provides that this additional fee of $25.00 is to be credited to the technical department of the association in lieu of the usual initial fee and first year's dues, no part of this sum is to be paid to the expert cost accountants, C. E. Knoeppel & Co., in charge of this work.

The morning session then was adjourned to meet immediately after the adjournment of the meeting of the exhibition committee in the afternoon.

B. D. Fuller, President.
A. O. Backert, Secretary.

Meeting of the Board of Directors of the American Foundrymen's Association, Inc., Saturday Afternoon, Feb. 16, 1918, William Penn Hotel, Pittsburgh.

This meeting of the board of directors was attended by the same members of the board as were present at the morning session. President Fuller was in the chair.

The following recommendations to the board were made by the 1917 exhibition committee:

"That the sum of $250 be paid from the earnings of the 1917 exhibition to the American Institute of Metals.

"That the sum of $1,000 from the earnings of the 1917 exhibition be credited to the technical fund of the American Foundrymen's Association, Inc.

"That the exhibitors be furnished with a condensed financial statement of the 1917 exhibition at Boston and that they be advised that no rebate will be paid this year for the reason that a large part of the earnings of the 1917 exhibition will be utilized for defraying the expenses of the War Service Committee of the American Foundrymen's Association, Inc.

"That the sum of $5,000 from the exhibition account, minus the salary of C. E. Hoyt at the rate of $400 per month from Dec 15, 1917, be set aside as a sinking fund to defray the preliminary expenses of the 1918 exhibition and that all funds in excess of this amount in the exhibition account be devoted to defraying the expenses of the War Service Committee, if necessary."

It was moved by H. A. Carpenter and seconded by W. A. Janssen that all of the foregoing recommendations be adopted. This motion prevailed without dissent.

President Fuller then announced the appointment of the following, as members of the 1918 exhibition committee:

H. R. Atwater, Cleveland Osborn Mfg. Co., Cleveland.
H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
A. E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
S. T. Johnston, S. Obermayer Co., Chicago.

V. E. Minich, Sand Mixing Machine Co., New York.
H. B. Swan, Cadillac Motor Car Co., Detroit.
A. O. Backert, Penton Publishing Co., Cleveland.
B. D. Fuller, chairman, Westinghouse Electric & Mfg. Co., Cleveland.

The question of charges for space for the 1918 exhibition, free admission to the members of the American Foundrymen's Association, Inc., and the American Institute of Metals and the charge for admission to representatives of the exhibitors, then was discussed at length. The desirability of eliminating the initial charge of $25 for the exhibitor's permit was pointed out by Mr. Hoyt and he also stated that considerable trouble could be avoided either by making no charge for admission or making a uniform charge to all. He also was of the opinion that exhibitors' representatives, including salesmen and operators, should be admitted without a charge of $1.00 as at present.

The consideration of these suggestions finally resulted in the presentation of a motion by A. E. Howell, seconded by V. E. Minich, that the charge for space for the 1918 exhibition be 55 cents per square foot for all space other than corner space and 65 cents per square foot for corner space and that a uniform admission fee of 25 cents for a single admission and $1.00 for the entire week of the exhibition, be paid by all, regardless of membership in the American Foundrymen's Association or the American Institute of Metals. This motion, in the form in which it was submitted, retains the charge of $25 for the exhibitor's permit and the customary charge of $1.00 for the entrance of exhibitor's representatives, including salesmen and operatives. It also provides for the payment of an admission fee of 25 cents for single admissions and $1 for the week, to all who desire to attend the exhibition, including members of the American Foundrymen's Association and the American Institute of Metals. It provides also for the issuing of one entrance ticket for the period of the show to each exhibitor. After considerable discussion this motion prevailed without dissent.

The auditing committee appointed at the morning session, consisting of Messrs. Minich and Pero, to consider the financial report of the 1917 exhibition, compiled and submitted by Ernst & Ernst, expert accountants, then was received. It was moved by S. T. Johnston and seconded by Jos. T. Speer that the report of the committee be received and filed.

There being no further business the meeting adjourned.

B. D. Fuller, President.
A. O. Backert, Secretary.

Minutes of Meetings of the Exhibition Committee

Meeting of the Exhibition Committee of the American Foundrymen's Association, Inc., William Penn Hotel, Pittsburgh, Saturday, Feb. 16, 1918.

A meeting of the Exhibition Committee of the American Foundrymen's Association, Inc., was held at the William Penn Hotel, Pittsburgh, Saturday, Feb. 16, 1918, for the purpose of considering the financial report of the exhibition manager and other subjects in connection with the final disposal of the affairs of the 1917 exhibition, held at Boston, Sept. 25-28, 1917.

The following were in attendance: A. O. Backert, H. A. Carpenter, A. E. Howell, S. T. Johnston, V. E. Minich and J. P. Pero. Although chairman of this committee, J. P. Pero requested B. D. Fuller, president of the association, to preside.

C. E. Hoyt, manager of the 1917 exhibition, presented a detailed financial statement of its operation, supplemented by the report of Ernst & Ernst, expert accountants. The detailed report presented by Mr. Hoyt, as well as that of Ernst & Ernst, are appended and constitute a part of the minutes of this meeting. A motion was made by S. T. Johnston and seconded by H. A. Carpenter, that the report be received and filed. This motion prevailed without dissent.

A. E. Howell offered a motion which provided for the payment to the American Institute of Metals of the sum of $250 from the earnings of the 1917 exhibition to aid in the continuation of its technical investigations; after being seconded by V. E. Minich, it was adopted without dissent.

S. T. Johnston then offered a motion recommending to the board of directors of the association that the sum of $1,000 be credited to the technical fund payable from the earnings of the 1917 exhibition. This motion, after being seconded by V. E. Minich, was adopted without dissent.

A. E. Howell offered a resolution recommending to the board of directors of the association that a financial report of the 1917 exhibition be made to each one of the exhibitors advising them also that no rebate will be paid this year because of the fact that the earnings of the 1917 exhibition are being heavily drawn upon for the continuation of the work of the War Service Committee. This motion was seconded by J. P. Pero and prevailed without dissent.

J. P. Pero then offered a resolution recommending to the board of directors that $5,000 of the total amount now in the exhibition account, minus the salary already paid to C. E. Hoyt at the rate of $400 per month from Dec. 15, 1917, be set aside as a sinking fund for defraying the preliminary expenses of the 1918 exhibition. This recommendation also provides that the work of the War Service Committee may be defrayed from this exhibition account to the amount provided for the sinking fund, but the expenses of the War Service Committee cannot be defrayed from this sinking fund

beyond the amount specified. This resolution was seconded by V. E. Minich and was unanimously adopted.

There being no further business the committee adjourned *sine die.*

J. P. Pero, Chairman.
A. O. Backert, Secretary.

Financial Report of Boston Exhibition.

February 16, 1916.

To the Officers and Directors
of the American Foundrymen's Association.

Gentlemen:—

I am pleased to submit the following as a report covering the Exhibit held in Mechanics building, Boston, the week of Sept. 24, 1917.

This was the second exhibit to be held under the auspices of the Department of Exhibits of the American Foundrymen's Association, Inc., and the twelfth held in conjunction with the annual meetings of the association. It was also the first one ever held in New England.

When Boston was being considered by the special committee, I believe it was the unanimous opinion of the members that we could not expect as successful an exhibit as those previously held, for the reason that we were so far away from the centers of the foundry industry of the country, and when a few weeks later, war was declared with Germany, a successful exhibit seemed even more doubtful.

It is, therefore, gratifying to report that both in number of exhibits and amount of space used, the Boston Exhibit exceeded the previous one, held in Cleveland, September, 1916. Although the committee selected Boston early in January, it was several weeks before contract arrangements were completed for Mechanics building.

We began our campaign by sending out informal announcements March 14, and on April 16 the first formal announcement and application blanks were mailed out. We circularized the industry more frequently and carried on a more extensive advertising campaign; also a more expensive one, as our financial statement will show.

Comparing the 1917 exhibit with 1916, we find a gain of nine in number of exhibits, the numbers being 146 at Cleveland and 155 at Boston. In the number of square feet sold we had a total of 43,674, exclusive of space used by Committee on Safety and Wentworth Institute, free space totaling approximately 1500 square feet. The total of sold space at Cleveland was 37,930 feet, and the net gain at Boston being 5744.

It, of course, would be expected that a larger exhibit would naturally be more expensive, but there were other reasons why the expense at Boston was considerably higher than ever before, the principal one being the high cost of material and labor. Another large item being the necessity of installing all of the power used.

In 1916 we inaugurated the plan of admitting members of the American Foundrymen's Association and the American Institute of Metals free, but continuing the usual charge of 25 cents admission for all others. No serious difficulties arose last year, probably on account of the meetings and exhibits being held at different places, but with all the activities in one building, as was the case in Boston, conditions were not satisfactory and I

believe it would be proper for you to consider whether it is a fair and wise policy to discriminate between the customers of your exhibitors.

I also wish to call your attention to our practice of charging an exhibition permit fee, and a charge of one dollar each extra exhibit representative. About the only argument advanced in favor of this practice, is revenue, and I would offer for your consideration a suggestion that the rates for space be sufficiently advanced to net the necessary income and do away with the above named extra charges.

If it is your pleasure I will not read the auditors' report of the Department of Exhibits, covering the Boston convention, and have prepared a more detailed statement, that you may be informed as to the detailed distribution of expenses under the auditors' several headings.

Respectfully submitted,

C. E. Hoyt, Manager of Department of Exhibits.

Final Report of Accounts of the Department of Exhibits, American Foundrymen's Association, Inc., from Nov. 1, 1916, to Dec. 24, 1917.

RECEIPTS—			
Surplus on 1916 Cleveland show.			$ 3,427.09
Received from space rentals.....			23,450.00
Received from exhibitors' permits			3,900.00
Received from gate receipts......			1,643.00
Received from Convention Bureau and City of Boston...........			5,000.00
Bank Interest			138.60
Bills payable			714.04
			$38,272.73
EXPENSES—			
Administration		$6,367.40	
Printing			
Stationery, circulars, rules and regulations, applications, contracts, tags, tickets, etc....	$ 513.52		
Circular letters	30.00		
Official programs	128.12		
Official directories	159.75	831.39	
Postage		298.68	
Committee traveling expense....		1,340.89	
Advertising:			
Special advertising cards (McGrath-Sherrill)	776.65		
Mailing invitations (National Adv. Co.)	175.69		
Expense in connection with Flag raising	110.78		
Signs on building............	12.50		
Penton Press (Program advertising, etc.)	72.56		
Other advertising matter......	41.12		
Iron Age	675.32		

Railway Mechanical Engineer.		524.30	
The Foundry		462.07	
Iron Trade Review		447.95	
Canadian Foundryman		101.20	
Metal Industry		81.68	
Brass World		80.00	3,561.82
Secretary's Assistant			245.00
General Expense:			
Audit 1916 account		30.00	
Allowance to Midland Machine account goods stolen		35.00	
Repairs to floor in aisle space		90.88	
Cartage and miscellaneous		36.53	192.41
Power:			
Electrical Installation, H. S. Potter		2,694.54	
Edison Electric Illuminating Co., current and erection of transformer		844.64	
M. C. M. A. wiring and current charges to Exhib		549.90	
M. C. M. A. extra lighting of building		72.55	
Labor, sorting and inventory for wire		15.00	
		$4,176.63	
Compressed air, Buerkel & Co.		1,193.50	
Air compressors		390.71	
Repairs to motor		35.00	
		$1,619.21	$5,795.84
Cost of power (brought forward)		$5,795.84	
M. C. M. A.:			
Gas	$114.08		
Rental of Hoisting Engine	150.00		
Water	64.00	328.08	
Total cost of power		$6,123.92	
Credit from exhibitors		2,308.28	
Net cost of power			3,815.64
Telephone and telegraph:			
Chicago office		25.22	
Boston office		56.06	81.28
Booths and decorations:			
Rental on material and supervision		1,082.50	
Freight and cartage		567.06	
Labor and expense of erection		713.53	

Extra lumber and material....	557.64		
Decorations	600.00		
Gross expense	3,520.73		
Credit from exhibitors...........	441.76		
Net cost of booth and decorations		3,078.97	
Signs:			
General signs	80.45		
Booth signs	334.50	414.95	
Manager's and assistants' travel and expense:			
C. E. Hoyt..................	482.41		
E. C. Hall....................	323.62		
W. H. Schulte................	59.92		
J. Reininga	63.60		
J. H. Kellogg................	68.90		
W. J. Slater..................	12.00	1,010.45	
Registration:			
Clerical	86.75		
Printing	114.10		
Supplies	66.75	267.60	
Watchman and janitor service:			
Janitors	341.56		
Telephone messengers	29.25		
Ticket takers and doormen...	78.38		
Disposing of rubbish.........	70.50		
Special watchmen	25.00	544.69	
Insurance		40.55	
Badges		333.50	
Building rental		3,675.00	
Music		313.00	
A. F. A. Technical Dept..........		2,500.00	28,913.22
Bills receivable			61.50
Cash on hand			9,298.01
			$38,272.73

Meeting of the 1918 Exhibition Committee of the American Foundrymen's Association, Inc., Saturday Afternoon, Feb. 16, 1918, William Penn Hotel, Pittsburgh.

Immediately following the adjournment of the meeting of the board of directors, a meeting of the 1918 Exhibition Committee of the American Foundrymen's Association, Inc., was called to order by President B. D. Fuller. The following were in attendance: H. R. Atwater, A. O. Backert, H. A. Carpenter, B. D. Fuller, A. E. Howell, S. T. Johnston, V. E. Minich and H. R. Swan.

It was reported that invitations had been received from the cities of Milwaukee, Columbus, Pittsburgh, Rochester, New York,

Asheville, Atlantic City, St. Louis and San Francisco, for holding the 1918 convention and exhibition of the American Foundrymen's Association at these places.

The exhibition facilities of Pittsburgh were carefully considered, but it was reported that considerable difficulty would be experienced in preparing the Exposition building on Duquesne Way for the convention and exhibition of the association. One part of the building now is occupied by a garage and another by an ice skating rink. A temporary floor it was stated might be laid on the ice skating rink entailing a cost of about $4,000 and arrangements also would have to be made with the owners of the garage to vacate for the period of the exhibition. It was believed that the expense of preparing this building for the exhibition would be too great and it was decided to consider the facilities afforded by other cities before giving Pittsburgh further consideration.

It was suggested that a committee be appointed to consist of the executive officers of the association, three members of the exhibition committee and the exhibition manager, to visit Milwaukee for the purpose of considering the facilities afforded by that place. It was moved by H. A. Carpenter and seconded by A. E. Howell, that this committee be appointed by the chairman and this motion prevailed without dissent. President Fuller then announced that in addition to the executive officers, Messrs. Atwater, Johnston and Minich as well as C. E. Hoyt, exhibition manager, constitute a committee to visit Milwaukee for the purpose of investigating its exhibition and convention facilities.

There being no further business, the meeting adjourned.

B. D. Fuller, President.
A. O. Backert, Secretary.

Minutes of Special Committee Meeting

MEETING OF THE SPECIAL COMMITTEE OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION, INC., EMPOWERED TO SELECT THE TIME AND PLACE OF THE 1918 CONVENTION AND EXHIBITION.

A meeting of the special committee appointed by the Board of Directors at Pittsburgh, Feb. 16, to select the time and place of the 1918 convention and exhibition of the association, was held at Milwaukee, Monday and Tuesday, Feb. 25 and 26. The following were in attendance: B. D. Fuller, President, Westinghouse Electric & Mfg. Co., Cleveland; C. E. Hoyt, exhibition manager, Chicago; H. R. Atwater, Cleveland Osborn Mfg. Co., Cleveland; S. T. Johnston, S. Obermayer Co., Chicago; V. E. Minich, Sand Mixing Machine Co., New York, and A. O. Backert, secretary-treasurer, Cleveland. S. Griswold Flagg, 3d, vice president, Stanley G. Flagg & Co., Philadelphia, was the only absentee.

The facilities of the Milwaukee Auditorium for holding the exhibition and providing meeting rooms for the technical sessions, were carefully investigated and it was found that the exhibition space was more than ample for the purposes and that four large meeting rooms were also available for the technical sessions.

W. H. Reese, secretary of the convention bureau of the Milwaukee Association of Commerce, reaffirmed the proposition made by wire to the secretary of offering to our organization gratis, the use of the Milwaukee Auditorium for our exhibition and convention. His proposal provides that Machinery Hall will be available for the installation of exhibits, the exhibition and removal of displays from Sept. 30 to Oct. 15, inclusive, and that the Arena will be available for the installation, display and removal of exhibits from Oct. 4 to 15 inclusive. In addition, one large meeting room is to be provided on Monday, Oct. 7; two meeting rooms or halls on Tuesday; four meeting rooms or halls on Wednesday; four on Thursday and three on Friday of convention week.

The entertainment was tentatively discussed and one large hall will be provided for a ball on Tuesday night, Oct. 8, if this proves to be acceptable to the Association, and one large hall will be available for the banquet on Thursday night of convention week.

After considering the foregoing proposition carefully, it was decided unanimously by the committee, on motion offered by S. T. Johnston and seconded by V. E. Minich, that the proposition made by Mr. W. H. Reese on behalf of the Milwaukee Association of Commerce, be accepted and the date of the meeting was fixed from Monday, Oct. 7, to Saturday, Oct. 12, 1918. Mr. Reese stated that he would embody all of the foregoing provisions of the proposition in a letter to the secretary for final acceptance by the Association.

There being no further business, the meeting adjourned.

B. D. FULLER, President.
A. O. BACKERT, Secretary.

Annual Report of the Secretary-Treasurer

To the President and members of the American Foundrymen's Association, Incorporated:

Notwithstanding the direct and indirect war activities engaged in by a large majority of the members of our organization, it is gratifying to report that during the fiscal year ended June 30, 1918, the membership showed a gain of 55, or over 5 per cent. The total enrollment on June 30 this year was 1072, compared with 1017 a year ago. The total paid membership was 1021, against 970 a year ago. During the 12-month period from July 1, 1917, to July 1, 1918, 116 new members were admitted to the organization, of whom 99 were active and 17 associate. Resignations during the year totaled 28, deaths 2 and 30 were dropped for nonpayment of dues. Active members carried on the books June 30, this year, totaled 927; associate, 128, and honorary, 17. A slight increase is noted in the total number of associate members although an insufficient number of foundrymen entitled to such participation in the affairs of our organization now is enrolled.

Increase in Dues Recommended

The expense involved in the conduct of the affairs of the association constantly are increasing and, therefore, a greater revenue is essential to defray the cost of its increased activities. Every effort has been made to make each of these activities self-supporting, but notwithstanding this, the increased cost of all material, labor, etc., is seriously curtailing the funds of our organization. We recommend an increase in the annual dues for active members of 20 per cent, to $12 per year and that of associate members to $6 per year. This will add to the revenue approximately $2000 per year and will enable the organization to defray the essential costs of conducting its affairs within any given fiscal year. Practically all of the technical societies of the country have been compelled to in-

crease their dues during the past few years and the American Foundrymen's association is one of the few which still is endeavoring to operate on a prewar basis. Therefore, we earnestly recommend to the officers, directors and members of this organization a careful consideration of this recommendation.

Complete data covering the membership of our organization follows:

		June 30, 1918
Active members, good standing	891	
Active members, delinquent	36	
Active members carried on books		927
Associate members, good standing	113	
Associate members, delinquent	15	
Associate members, carried on books		128
Honorary members		17
Total book membership		1072
Total membership paid to June 30, 1918		1021
Total membership paid to June 30, 1917		970
Gain for year, 5 per cent or		51
Resignations during year		28
Deaths		2
Dropped for nonpayment of dues		30

New members received during year 1917-1918, 116, of which 99 were active and 17 associate.

Accompanying this report is a chart showing the membership of the American Foundrymen's Association, Inc., each year since the date of its organization in 1896.

Finances

Although the expenses of our organization increased tremendously during the last year, nevertheless, we are able to report a cash balance in the treasury on June 30, this year, of $688.65, compared with $594.85, June 30, 1917, and $203.72 the previous year. The total receipts from all sources amounted to $18,804.89 and the disbursements were $18,711.09. However, from this total, receipts for dues and subscriptions amounted to only $10,152.31. From the exhibition department was received $1000 and in addition $4184.68 was transferred from the exhibition to the technical account to defray the expenses of the activities of the war service board at Washington, which conducted offices in that city for a period of about six months, in charge of C. E. Hoyt, secretary of this

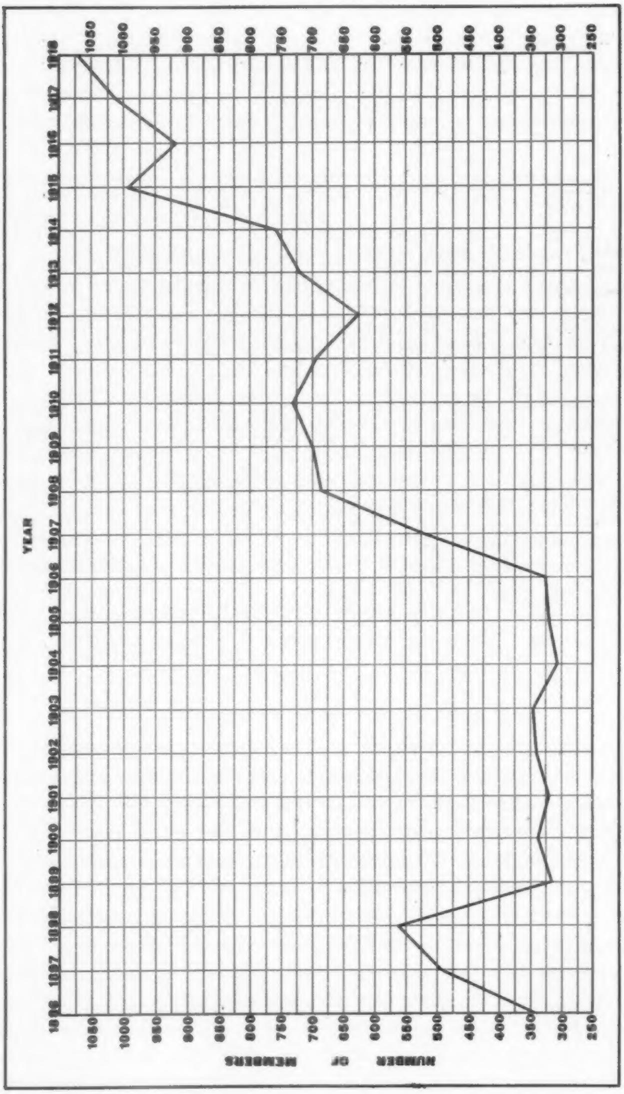


CHART SHOWING GROWTH IN MEMBERSHIP OF AMERICAN FOUNDRYMEN'S ASSOCIATION

board. In view of the transfer of this sum from the exhibition account, no dividend from the Boston exhibition was returned to the exhibitors, all of whom gladly consented to the transfer of this amount to the technical department to defray the cost of these Washington activities.

The Association still has a Research Fund amounting to $357.71, which has not been drawn upon for the purpose for which it was set aside. Also, during the year the Association derived financial aid from its cost work amounting to $816.13, from which expenses for conducting this work are to be deducted, but a balance in favor of our organization still will remain after defraying the entire cost of this undertaking.

The largest item of expense is for printing and stationery, amounting to $4,633.80. Also, the War Service Board activities involved an expenditure of $4,184.68. From the exhibition account was paid to the American Institute of Metals, now the Institute of Metals Division of the American Institute of Mining Engineers, the sum of $250.

Appended herewith are the financial statements of Ernst & Ernst, Certified Public Accountants, who audited the books of both the technical and exhibition departments. It will be noted that the exhibition account audit was dated Dec. 24, 1917, when the final affairs of the Boston exhibition were closed.

For the aid and support given him throughout the year by President Benj. D. Fuller, the board of directors, and his assistants, your secretary-treasurer extends his warm appreciation and sincere thanks.

Respectfully submitted,

A. O. BACKERT, *Secretary-Treasurer.*

Auditor's Financial Report of Technical Department

Cleveland, Aug. 6, 1918.

Mr. A. O. Backert, Secretary-Treasurer,
The American Foundrymen's Association, Inc.,
Cleveland.

Dear Sir:

Pursuant to your request, we have audited the recorded cash receipts and disbursements of the American Foundrymen's Association, Inc., Cleveland, for the year ended June 30, 1918, and submit herewith our report.

A summary of the cash transactions for the above stated period is set forth in the following statement:

CASH BALANCE, June 30, 1917—		
As shown by our previous report.........		$594.85
Transactions for the Year		
RECEIPTS—		
As shown in detail exhibit.................	$18,804.89	
DISBURSEMENTS—		
As shown in detail exhibit................	18,711.09	93.80
CASH BALANCE, June 30, 1918......		$688.65

We verified cash on deposit at June 30, 1918, amounting to $688.65 by direct correspondence with the depository banks and reconcilement of the balances reported with the balance shown by the books, as set forth in exhibit included and made a part of this report.

All recorded cash receipts for the year ended June 30, 1918, amounting to $18,804.89, were traced by us directly into the bank deposits, and all recorded cash disbursements for the same period, aggregating $18,711.09, were found to be supported by officially signed and cancelled bank checks on file with the following exceptions:

Check date	Payable to	Amount	Exception
Nov. 27, 1917...	Kilbane, Sara V..	$ 10.00	Not signed by secretary-treasurer.
Feby. 11, 1917...	Hoyt, C. E.......	112.30	Not endorsed by payee.

All recorded cash disbursements were found to be supported by receipts, invoices and other supporting data on file except as stated below.

Date	Payee	Amount	Exception
Dec. 22, 1917...	Hoyt, C. E.......	$500.00	Petty cash for War Service Board—no support.
Feby. 26, 1918..	Backert, A. O.....	150.00	Voucher not signed.

We have traced all recorded cash received in payment of dues, etc., directly to the credit of the various members' accounts. Attention is called, however, to the fact that payment of Wm. Hoernke on July 15, 1917, amounting to $10.00 and payment of

B. W. Spencer on October 2, 1917, amounting to $10.00, had not been posted to their subsidiary card records.

Exhibits setting forth membership dues unpaid at June 30, 1918, aggregating $560, and resigned members' dues, unpaid at June 30, 1918, amounting to $190, are included and made a part of this report. The amounts were verified by trial balance of the individual accounts, but we did not correspond with the individual members to further verify the records.

In the following statement is set forth a summary of the Inventory of Supplies, Furniture and Fixtures, Emblems and balance of American Foundrymen's Association Cost Work, as submitted to us by the management.

Furniture and Fixtures	$250.00
Printing and Stationery	502.00
Emblems	40.50
American Foundrymen's Association Cost Work Account	816.12
Total	$1,608.62

No liabilities were disclosed by the Association's records or reported to us.

Very truly yours,

(Signed) ERNST & ERNST,

(SEAL) Certified Public Accountants.

Cash Receipts and Disbursements

American Foundrymen's Association, Inc., Cleveland

For the year ended June 30, 1918.

CASH BALANCE June 30, 1917, as shown by our previous report		$594.85

TRANSACTIONS FOR THE YEAR

Receipts

Dues and Subscriptions	$10,152.31
Convention	1,930.18
A. F. A. Share of 1917 Exhibition	1,000.00
McFadden, W. H	5.00
American Institute of Metals	10.24
Research Fund—Interest	20.60
Sale of Emblems	34.00
Special Printing	64.50
War Service Board—Technical Dept	4,184.68
Cost Work Account	816.13
Exhibition Committee Account	587.25
Total Receipts	$18,804.89

Disbursements

Printing and Stationery	$ 4,633.80
Refund of Due	40.00
Office Expense	237.46
Traveling Expense	331.60
Convention Expense	2,794.27
Postage	746.14
Administrative Salary	1,800.00
Clerical Salaries	1,330.00
Special Printing	47.06
Dues in Other Association	55.00
Cost Work Committee Expense	900.67
Exhibition Committee	454.68
War Service Work	4,184.68
Committee Meeting Expense	1,155.73
Total Disbursements	$18,711.09

RECEIPTS EXCEED DISBURSEMENTS	93.80
CASH ON DEPOSIT JUNE 30, 1918	$688.65

Auditor's Report of the Exhibition Department.

Chicago, Jan. 12, 1918.

Mr. Benjamin D. Fuller, President,
American Foundrymen's Association, Inc.,
Cleveland.

Dear Sir—

We have made an examination of the books of account and records of the American Foundrymen's Association, Inc., for the period of Nov. 1, 1916, to Dec. 24, 1917, and submit herewith our report showing, in our opinion, the condition of the Association at December 24, 1917, and the earnings for the period under examination.

The financial condition of the Association at Dec. 24, 1917, is shown below:

ASSETS—	
Cash in Bank	$9,305.76
Accounts Receivable	61.50
	$9,367.26
LIABILITIES—	
Accounts Payable	$ 714.04
Surplus Income	8,653.22
	$9,367.26

The excess of income over expense for the period under review was $5,226.13 as shown in a detailed statement attached; we also include in our report an exhibit of the transactions affecting the surplus income.

We examined the cash records and compared all cancelled checks returned by the bank with the cash book entries and noted no difference.

Cash on deposit with the Superior Savings & Trust Co., Cleveland, was confirmed by direct communication with the depositary.

Accounts Receivable totaling $61.50 consisted of the following:

Mott Sand Blast Mfg. Co., New York	$ 2.00
Rivet Lathe & Grinder Co., Boston, Mass.	30.50
Chicago Safe & Mdse. Co., 79 W. Lake St.	4.00
United Metal Hose Co., New York	25.00
	$61.50

The amount due creditors for expenses incurred were as follows:

H. E. Potter, Boston, Mass. (Power)	$694.54
Underwood Typewriter Co.	19.50
	$714.04

As requested, we did not correspond with any of the foregoing debtors or creditors to verify the balances of their accounts as shown by the books of the Association.

In our examination of vouchers for expenditures we were unable to locate the following vouchers:

Number	Name	Amount
120	Sullivan Machinery Co.	$ 38.16
121	C. E. Hoyt	41.45
122	C. E. Hoyt	198.00
123	Chicago Pneumatic Tool Co.	91.50
126	Cement Products Exp. Co.	50.20
127	Bastian Bros.	434.26
129	J. H. Kellogg	11.25
131	Keyser Cartage Co.	2.25
132	C. E. Hoyt	500.00
147	E. C. Atkins	15.00
159	Carborundum Co.	18.70
162	Chicago Eye Shield Co.	7.50
172	Compania De Broz De Net	7.50
174	Dalton Adding Machine Co.	9.20
177	Wm. Demmiler Bros.	8.70
202	Herman A. Holz	3.75
213	Lake Erie Smelting & Refining Co.	10.00
369	Perry Advertising System	5.00
371	J. C. Drake & Co.	26.65

Yours very truly,
(Signed) Ernst & Ernst,
(seal) Certified Public Accountants.

Exhibition Department, American Foundrymen's Association, Incorporated.

Income and Expense
Nov. 1, 1916, to Dec. 24, 1917

INCOME GUARANTEE—			
Received from city of Boston and Boston Chamber of Commerce		$ 5,000.00	
BOSTON EXHIBITION—			
Space Rentals	$23,450.00		
Exhibitors' Permits	3,900.00		
Gate Receipts	1,643.00	28,993.00	
INTEREST ON BANK BALANCES		138.60	34,131.60
EXPENSE—			
Administration		6,367.40	
Advertising		3,561.82	
Badges		333.50	
Booths		3,078.97	
General		192.41	
Insurance		40.55	
Manager's assistant		1,010.45	
Music and entertainment		313.00	
Printing and stationery		823.64	
Postage		298.68	
Power		3,815.64	
Registration		267.60	
Rental		3,675.00	
Secretary's Assistant		245.00	
Signs		414.95	
Telephone and telegraph		81.28	
Traveling - committee		1,340.89	
Watchmen and janitor		544.69	
American Foundrymen's Association Technical Department		2,500.00	28,905.47
			$5,226.13

EXHIBITION DEPARTMENT
AMERICAN FOUNDRYMEN'S ASSOCIATION, INC.

Reconciliation of Surplus—Income.
Dec. 24th, 1917.

Balance per books Nov. 1, 1916............			$6,829.60
DEDUCTIONS—			
American Foundrymen's Association pro-rate of Cleveland exhibition profits		$1,000.00	
American Institute of Metals pro-rate of Cleveland exhibition profits......		166.50	
Ten per cent space rental rebates to Cleveland exhibition exhibitors......		2,018.60	
Uncollectable accounts charged off:			
Berkshire Mfg. Co.	$16.64		
Mott Sand Blast Co..................	20.30	36.94	
Expenses of period prior to Oct. 31-16 paid after that date...........		212.97	3,435.01
			$3,394.59
ADDITIONS—			
Collection of accounts not on books at Oct. 31-16:			
Pangborn Corp.	27.50		
Federal Foundry Supply Co...........	5.00	32.50	
Profits on Boston Exhibition..........		5,226.13	5,258.63
			$8,653.22

A Message to A. F. A. Members from the Western Front

By Capt. R. A. Bull

To the Members of the American Foundrymen's Association:

The chairman of your committee on papers has written across the seas asking me to forward greetings appropriate for your convention to be held within a few weeks at Milwaukee. Your secretary has seconded the request. I am much indebted to both of these gentlemen for co-operation given me when the expanding activities of the association made heavy demands upon its officers, and I, therefore, find it difficult to refuse them. But my compliance is mainly due to a desire to testify to Uncle Sam's excellent care of his soldiers, and to add, if possible, to your pride in the morale of our fighting men.

If I occupied with the American Expeditionary Forces a position of exposure to dangers and hardships, or if I performed a relatively important function in the military organization in France, I would hesitate to voice my sentiments, which in either case might be mistaken for self-praise. At the outset let me confess that since arriving in France in May of this year, I have been a perfect stranger to unusual hazards of life and to physical discomforts.

Many things must be done by the noncombatant branches of the American army in France, back of the battle lines, in what is called the Service of Supplies. Those who are doing this work make no pretensions to performing the tasks of heroes, and feel the more keenly their great obligations to their comrades at the front, because of their own assignments in the rear. Many of them have seen, as I have, what a wreck of the yet living body can be made by the enemy's bullet, shell, bomb and gas; have witnessed the fortitude of wounded men

under intense suffering; have observed the morale of our soldiers detained for treatment in the rear, keenly anxious to return to the trenches to settle the score with Fritz. Seeing all of this, and realizing how effectively he is hitting the Boche line, my respect for the Yankee fighting man, whatever may be his rank, is supreme. Many of the youths who man the guns, who carry the cold steel over the top, who bridge the streams under the enemy's fire, who minister to the wounded where they fall, are your own kinsmen. How proudly you must bear yourselves in the knowledge that those of your own flesh and blood are bearing this burden! And if perchance those whom you love, must make the supreme sacrifice, how glorious a heritage their dauntless courage will leave to you!

The things that are worse than death include subjection to Prussianism, with all the atrocities of which it is the parent. I have talked with some who witnessed the horrors perpetrated by the Kaiser's minions upon the enslaved inhabitants of those sections of France and Belgium which for some time have been occupied by the enemy. I saw, in the critical days of the supreme effort made by the German army to capture Paris, the pitiable condition of old men, women and little children, fleeing from the wrath of the relentless Hun, carrying on their backs and in their arms all of their earthly possessions they could save. I cannot forget the expression of intense suffering on the faces of the women; of sorrow and bewilderment on those of the children, whose glances at every stranger seemed to ask the reason for it all. I have been proud of my nationality to learn how our own Red Cross has comforted many of those unhappy refugees. Every branch of the service has when possible taken a hand in relief work. One little boy has for some time called his home an American camp in the zone of advance where his fine, manly appearance in an olive-drab uniform drew my attention. I learned that U. S. engineer troops had discovered him at his daily task of getting subsistence from the camp garbage cans. Charlie was a homeless, friendless war waif of eight years. His father had been killed and his mother had died. He had been adopted by the engineers who found and left him in the efficient care of Y. M. C. A. representatives

until the return from the front of his big-hearted foster-brothers.

It is always comforting to know that our own are in good hands. You have been informed through many channels that the American soldier in France is well cared for. I want to add my endorsement. The medical corps is zealous in its care for the sick and wounded, and in sanitary work. The strictest attention is given to drinking water. Troops quartered in barracks are housed with special regard for ventilation and cleanliness. In the camps in France where I have been stationed there are excellent bath houses, better than those at the camp in the states where I was formerly on duty. The quartermaster corps is rendering very efficient service in procuring and distributing clothing and other supplies. It sells tobacco and candies to the soldiers at very low prices. Twenty cigarettes of a popular American brand may be obtained for 5 cents. In most localities, and where conditions permit, the army messes have the most wholesome food, in liberal quantities, well prepared. There is no lack of sugar, wheat flour or meat in the American Expeditionary Force, mainly due, as we realize, to the cheerful self-denial of the folks back home. Just as rapidly as our troops arrive do their supplies seem to precede them.

The American Red Cross is surpassing all its magnificent traditions. It is found everywhere in France, seeking to serve, leaving with those who have felt its influence, grateful recollections that will never fade. Its chief function of caring for those selected by fate as the victims of the enemy's instruments of torture and suffering is being performed with the greatest skill and dispatch, in superb defiance of danger to those who minister. The inspiring devotion of its hard-working, consecrated men and women will constitute one of the most glorious memories of this conflict. Linked as its activities are with every patriotic home in America, its appeal to the sentiment of the Yankee in France makes it his ideal of devoted service that never fails.

The needs of the "Armee Americaine" have been thoughtfully considered apart from purely physical comforts. At the convalescent and rest camps every available means is supplied

for cheerful, wholesome entertainment and recreation, with splendid effect on the spirit of the men. By long odds the greatest single factor in maintaining, day in and day out, the morale of the American soldier is the Y. M. C. A. There is the atmosphere of a democratic club, the resort of the finest type of man that has been created—the Yankee buck private. The nightly entertainments in the "Y" huts back of the line, the comforts in the advanced stations along the line, the single idea of service and the spirit of good cheer and clean living actuating this and similar organizations bridge the enormous gap between the home in America and the camp in France as no agency of different character could possibly do. The men and women who wear the red triangle have exhibited in many cases a heroic and, in general, a sympathetic spirit of helpfulness that makes an irresistible appeal. No mollycoddle tendency exists in the Y. M. C. A. in France to detract from its drawing power among red-blooded men. I have heard the "Y" leader at a Sunday night sing-song preceding a prayer and a soulful talk, conduct the singing of "Hail! Hail! the Gang's all here. What the Hell Do We Care Now?" with as much feeling as accompanied "Onward, Christian Soldiers", which followed it.

Some may wonder if the injunction to right living reaches the hearts of men whose business it is to kill Germans. I have a canteen picked up at the front, which once belonged to a doughboy who presumably made the great sacrifice. On the canteen are scratched the soldier's name and numerous characters including these words: "If a man ain't true to his wife how in Hell can he be true to his country?" That is the essence of fidelity to trust, domestic and public, which I believe to be one of the outstanding characteristics of your plain-spoken, tin-hatted representatives in France.

Mention of the spirit in your army overseas is incomplete without reference to the women at home. The typical American in France has created in his mind a halo about them. In his leisure hours he takes from the treasure-chest of his memory those American women who are especially dear to him, who are courageously keeping the home fires burning. Figuratively he places these heroines before him on the pedestals

erected for them in his thought through the knowledge of their cheerful sacrifices. He sees them industriously making socks and bandages; conserving every grain of sugar and every ounce of flour; anxiously scanning the published casualty lists. He hears them praying to the Author of Liberty for the safety of him, its defender. And when he has received, as he invariably does from this mental journey home, the inspiration that no one now living in America can appreciate, he applies himself vigorously to the job of killing Huns with a solemn vow that *his* womenfolk, in this or any other generation, shall never suffer at the hands of war-mad Germany what has come to the women in France and Belgium.

Tribute has been paid to the splendid work of our allies countless times. Appreciation compels me to mention it at the risk of seeming to repeat something which needs no emphasis at my humble hands. I had the honor, a few days ago, to meet an elderly French general who has received 11 wounds in this war. One of them left an ugly scar on his chin, another a deep depression in his skull. His right arm is gone at the elbow. The general in fluent English, with the ardor of youth, discussed the war at length with a group of junior American officers. His analysis of conditions was keen. His praise of our troops was emphatic. His modesty and genuine friendliness were superb. This battle-scarred old veteran is still rendering valiant service. His spirit is like that of the typical French soldier today. After four of the most trying years through which any nation could pass, the French maintain their poise and their vigor to a degree that is amazing. Unstinted praise is demanded by such an inspiring demonstration.

The British soldier is entitled to our admiration without bounds. He has been a complete failure—as his own press-agent. As a tenacious, courageous bull-dog who quietly fights on until he or his adversary is done for, he merits our highest esteem. John Bull's allies are under an enormous obligation to these reticent chaps who went quickly from the British Isles and Colonies to the rescue of Belgium and France, and who, without any fuss, have been doggedly seeing the thing through. Do not forget the debt of America to the British navy. And remember that the British empire has to date fur-

nished, according to press reports, about eight and one-half millions of her very best men to save democracy.

I can appropriately testify to the earnest appreciation of the men in the American Expeditionary Force for the splendid work being done by the industrial army in the states. Through the appreciated enterprise of certain journalists we receive daily European editions of several well-known American and English papers. From these and the admirable weekly paper of the American Expeditionary Force, called *The Stars and Stripes,* we are kept posted as to many developments concerning the war in our own native land. We see in France now many of the results of the labor at home. We know vastly more will follow as quickly as human ingenuity and untiring energy can bring them here. Your men in France are thrilled by the progress in shipbuilding, by the passage of the "man power" bill. Our location has not distorted our sense of perspective. We realize that millions of men and women and many children must labor in America that the vast numbers of her sons in Europe may have the means to finish their task quickly. And we regard those who are unceasingly rendering this service at home and who are best qualified for it, as equal in devotion to duty with those who wear the overseas cap.

The members of the American Foundrymen's association and the other organizations co-operating with it in the 1918 convention have before them a task of huge proportions in doing their full duty at this time. Anyone who knows them as I do, knows they will fulfill every obligation, and need no urging. You realize that every moment of time or ounce of energy wasted in the United States increases the casualty lists of our army. The allies are steadily pushing toward Berlin those who would have made it the capital of a conquered world. This progress can only be speeded up by the most vigorous co-operation at home with that of those whose job it is to shoot and cut their way through the resisting lines of the enemy. No sacrifice that we can make is comparable in the slightest degree with that being made every hour in France by our men whose blood is bathing her soil. Those who are going through Hell for you and me are confidently looking toward America for that supreme manifestation of speed and efficiency of which

her people are capable. Their belief that they are being backed up to the limit at home is as steadfast as is their faith in God. Being near to but not of these heroes, without credentials from them but voluntarily speaking for them as an individual, I salute you as brother-patriots, whose sole purpose now is the preservation of liberty for our own and future generations.

(Signed) R. A. BULL.

(Self-censored, R. A. Bull, Capt. Ord. Dept., A. E. F.)
France, Aug. 29, 1918. (Mailed Sept. 3, 1918.)

Report of the American Foundrymen's War Service Committee

To the President and Members of the American Foundrymen's Association, Inc.:

December 21, 1918, completed one year's service as secretary of the American Foundrymen's Association War Service Committee, and I am pleased to submit the following report:

The appointment of a War Service Committee by the American Foundrymen's association was authorized by resolution passed at the annual convention in Boston, Sept. 26, 1917, and was prompted by the earnest desire on the part of the officers and members to serve the government in every way possible during the war period. Immediately following the declaration of war, President J. P. Pero, on behalf of the Association, had promptly offered the services of our organization to the President of United States.

The resolution provided that the committee appointed should consist of five men who would represent the gray iron, malleable iron, steel and nonferrous castings industries, that they should be chosen irrespective of their membership in any organization, to serve without compensation, and to give such assistance, as a board operating direct, or as a central board governing subsidiary boards or committees, to the government of the United States as might be possible with the approval of said government. The resolution further authorized proper officers of the American Foundrymen's association to disburse such sums as might be necessary to defray the proper expenses

for conducting the work of the committee in co-operating with the government.

Members of Committee Appointed

In accordance with this resolution President Benjamin D. Fuller appointed the following committee:

Major R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh, Chairman.

H. D. Miles, Buffalo Foundry & Machine Co., Buffalo, representing the gray iron foundry industry, vice chairman.

C. C. Smith, Union Steel Castings Co., Pittsburgh, representing the steel foundry industry.

J. C. Haswell, Dayton Malleable Iron Co., Dayton, O., representing the malleable iron foundry industry.

G. H. Clamer, Ajax Metal Co., Philadelphia, representing the nonferrous castings industry.

On December 12, 1917, Chairman Bull attended a meeting in Washington of all War Service Committee chairmen, called by the Chamber of Commerce of the United States. At this meeting those in attendance were impressed with the importance of each industry at once organizing so as to co-operate with the government in securing information as to their respective industries and available plant capacity.

On Dec. 21 an informal meeting of the officers of the Association was held in Pittsburgh to consider Chairman Bull's report of the Washington meeting. Major Bull recommended that an office be immediately opened in Washington and that a secretary and the necessary corps of assistants be engaged. This recommendation was unanimously accepted, and acting in accordance with the resolution passed at Boston, President Fuller authorized the committee to make such arrangements, and appointed C. E. Hoyt, secretary of the Committee.

During the last week of December, 1917, the American Foundrymen's War Service Committee opened headquarters at 918 F street, N. W., Washington, D. C., and on Dec. 31 the first meeting of the Committee was held in its offices in Washington. This meeting was continued over to Jan. 2, 1918. The Committee conferred with representatives of the War Industries Board and with the War Service Committee of the Chamber of

Commerce of the United States, and plans for organization and work were decided upon.

On the last day of the meeting, C. C. Smith tendered his resignation as a member of the Committee, having accepted a commission as a major in the Gun Division of the Department of Ordnance, and a few days later Major Bull found it necessary to resign as chairman and a member of the Committee, having been called to active service in the Ordnance Department. President Fuller thereupon appointed vice chairman H. D. Miles as chairman of the War Service Committee, and Ralph H. West of the West Steel Casting Co., Cleveland, to the vacancy caused by the resignation of Major Smith.

Questionnaire Sent to Foundrymen

The first work of the Washington office was to prepare a form of questionnaire, and when these were approved by the Committee they were sent out simultaneously to the gray iron, steel, malleable iron, brass and aluminum foundries of the United States, together with a patriotic appeal to the foundrymen of the country to place their capacity at the disposal of the government if needed.

The next step was to place the services of the Committee at the disposal of all the Departments of Ordnance, the Emergency Fleet Corporation, Quartermaster's Department, Cantonment Division and the Navy. As soon as it was generally understood that the purpose of our War Service Committee was solely one of information and assistance, many in the previously named departments of the government began calling on our Committee for information.

On Jan. 16, 1918, the Engineering Bureau requested a conference on specifications for semisteel shells. This resulted in calling to Washington a special committee to confer with the Engineering Bureau, and a number of suggestions then made for the conducting of experiments in the manufacture and testing of these shells were adopted. Our office continued to keep in daily contact with the various departments and to assist the many foundrymen who came to Washington seeking information.

In February the attention of the Committee was called to the increased shortage in foundry pig iron, due primarily to an apparent disposition on the part of government authorities to give greater assistance to furnaces producing steel-making irons than to those making foundry grades. Continued reports from both foundry and furnace men affected, resulted in calling another committee meeting on March 18, at which time a strong brief was submitted to the chairman of the Raw Materials Section of the War Industries Board, citing facts as to total tonnage that had been converted from foundry to steel-making irons and statements were exhibited which showed that other furnaces were contemplating a change, feeling that by so doing they could secure greater assistance from the government.

At this conference the Committee was advised that it was the impression of those in authority at Washington that foundries other than steel foundries were not very important to the government program. This statement prompted a compilation of statistics from the questionnaires that had been returned, and on March 20, 1918, we submitted figures showing that of the 2060 gray iron foundries which had reported to us, 1106 stated that they were doing important government work, either directly or indirectly. This statement, surprising to the authorities, prompted them to suggest that we at once undertake to secure more definite information as to the importance of this industry and to ascertain through a new questionnaire the approximate tonnage necessary to produce castings under contract both for direct and indirect government work, including all railroad work.

Acting on this suggestion we prepared a new questionnaire, submitted it to the War Industries Board for its approval, and then mailed it out to the entire industry.

Pig Iron Shortage Became Acute

In the meantime the pig iron situation had become so serious that the iron ore and lake transportation section of the Iron and Steel institute, representing the blast furnace interests, decided that something must be done quickly, and they prepared and sent out questionnaires to all blast furnaces, with forms similar to ours, to be distributed by each blast furnace to its

customers, and while the War Industries Board urged us to continue compiling statistics, we recognized at once that the Iron and Steel institute committee was in a position to secure this information in an efficient way, and to avoid duplication of effort we turned this work over to them.

It must be remembered that our War Service Committee, unlike some others, was organized solely for the purpose of giving assistance to the government, and that in an industry so large and diversified as the foundry industry it was impossible to have a committee that could speak for the industry. In the question of pig iron, however, the Committee worked with a view to the industry's interests, and whenever opportunity presented our influence was used to the end that available existing foundry capacity be used, and to discourage the building of new foundries, that we might not have an over-built industry after the war.

Soon after opening our office in Washington we recognized that in order to give efficient service it would be necessary to establish points of contact through possible subcommittees in all foundry centers, but before such a plan was put into operation Colonel Tripp of the Ordnance Department decided to establish nine production districts. These districts, when organized, were of great assistance to the government, but did not wholly answer the problems of a scattered industry. This fact was recognized by the War Industries Board, and the latter part of May the organization of the Resources and Conversion of Industry section of the War Industries Board was established, with C. A. Otis as chief, and in June, 19 regional districts were established, enabling that department to do for all industries what we had planned to do for the foundry industry.

The establishment of nine production districts of ordnance and the previously mentioned districts of the War Industries Board made the government less dependent on voluntary committees and unofficial organizations, and as the funds originally appropriated for War Service work were practically exhausted, the Committee and officers of the Association took under consideration the advisability of closing the Washington office.

When this became known a number of government officials expressed the hope that the office would be continued, and from George N. Peek, head of the Industries Section of the War Industries Board, and Mr. Elliott Goodwin, secretary of the Chamber of Commerce of the United States, we received letters expressing their appreciation of the work that had been done, and advising that from various sources they had been told that our office had been helpful. Nevertheless, it was decided that the Washington office could be closed without inconvenience to the government departments we had been serving. Accordingly, announcement was made that our records had been made available to the War Industries Board, and on June 30 the Washington office was closed, and further work of the War Service Committee was conducted from the Chicago office of the Department of Exhibits of the American Foundrymen's association.

During the week of Dec. 2, 1918, in response to a call from Chairman Miles, our entire Committee attended the great meeting of War Service Committees at Atlantic City and participated in the deliberations. At that meeting announcement was made that the War Industries Board and other bodies which were created for the period of the war would be immediately disbanded, but the suggestion was made in the form of a resolution that the work of the War Service Committees be continued.

At the request of the Historical Branch, War Plans Division, General Staff, we filed a report of our committee work, so that when this history is read it will show in the records that the American Foundrymen's association promptly responded to the call of the government and did its part toward bringing the great world war to a victorious and glorious end for our country and our Allies. All of the records that were turned over to the War Industries Board have been returned to us and will be a part of our permanent files on the foundry industry.

The funds for the conduct of this work were appropriated from the account of the Department of Exhibits by action of the board of directors, and a word of appreciation is due to the exhibitors for their almost unanimous approval when an-

nouncement of this action was made. To President Benjamin D. Fuller, Major R. A. Bull, Chairman H. D. Miles, and the members of the Committee, who gave generously of their time without compensation, the thanks and appreciation of the industry also are due.

Financial Statement

Following is the financial statement covering expenditures of the War Service Committee for the year ending Dec. 21, 1918:

Secretary's travel	$ 526.92
Secretary's salary	1100.00
Printing and stationery	516.94
Stenography	722.25
Clerical	625.00
Postage	362.00
General expense	10.69
Rent	178.75
Office supplies	51.52
Telephone and telegraph	112.50
Furniture	215.10
Towel supply	10.40
Door signs	3.00
Total expenses	$4435.07
Proceeds from sale of furniture	105.50
Net cost of War Service Committee	$4329.57

Respectfully submitted,

AMERICAN FOUNDRYMEN'S WAR SERVICE COMMITTEE,

C. E. HOYT, SECRETARY.

Ordnance Steel for the Army and Navy

By John Howe Hall, High Bridge, N. J.

The tests which have to be met on the army and navy steels are shown in the accompanying tables. For purposes of rapid comparison, I have shown the specifications of the army and navy, the American Society for Testing Materials and Lloyd's Register for similar steels in groups. The last group in this list requires no comment except that certain castings on the army blue prints are marked simply "Cast Steel" and this has been interpreted to mean a good grade of material such as would be supplied for commercial work and no specifications either chemical or physical have been called for on it.

It will be seen on looking over the chemical specifications in the first two columns of the table that in spite of the earnest efforts that have been made by the committee of the Steel Founders Society, it is not yet possible in a great many cases to use one and the same steel for both army and navy work.

Various Processes May Be Used

The army has consented to raise its limits on phosphorus to 0.06 per cent and on sulphur to 0.08 per cent for No. 1 and No. 2 steel and the same limits are allowed for No. 3 steel, provided the carbon is not over 0.35 per cent. If the carbon is over 0.35 per cent, phosphorus must be below 0.05 per cent and sulphur 0.07 per cent. This makes it possible to turn out Army No. 1 and No. 2 steel from either acid open-hearth, acid electric, basic open-hearth or in many cases from the Tropenas converter without undue difficulty with fuel and raw material. The army No. 3 steel with phosphorus at 0.05 per cent and sulphur at 0.07 per cent cannot be met in the Tropenas converter by most makers because the specification of the army

forbidding the rapid cooling of castings after annealing makes it impossible to meet the physical tests with carbon below 0.35 per cent. This steel, therefore, is usually made in either the open-hearth or the electric furnace.

The specifications of the navy as written call for such low phosphorus and especially sulphur that the Tropenas foundries and in some cases the acid open-hearth foundries will find it impossible to meet the chemical specifications under existing conditions. It is the understanding of the writer, however, that the navy has waived the chemical specifications within reasonable limits on certain classes of castings on which they could be assured that the manufacturer turned out a high grade of

A COMPARISON OF SPECIFICATIONS

	Phosphorus	Sulphur	Tensile strength	Elastic limit	Elongation in 2 inches per cent	Contraction of area per cent	Bend test degrees
SOFT STEELS							
Army No. 1...	0.06	0.08	60,000	27,000	22	30	...
Navy B.......	0.06	0.05	60,000	27,000	22	30	120
ASTM "Soft".	0.06*	0.06	60,000	27,000	22	30	120
Lloyd's Ship...	...	...	58,240 to 78,400	.....	20	..	120†
Remarks:—"Drop" and Hammering tests also specified.							
MEDIUM STEELS							
Army No. 2...	0.06	0.08	70,000	31,500	18	25	...
Navy D........	0.05	0.05	70,000	31,500	22	30	120
ASTM "Med'm"	0.06*	0.06	70,000	31,500	18	25	90
HARD STEELS							
Army No. 3...	0.05	0.07‡	80,000	36,000	15	20	..
Navy A........	0.05	0.05	80,000	36,000	17	20	90
ASTM "Hard".	0.06*	0.06	80,000	36,000	15	20	..
SPECIAL STEELS							
Army "Special"	0.05	0.07	90,000	55,000	15	25	...
Navy "Alloy F"	0.05	0.05	85,000	53,000	22	35	120

STEELS WITHOUT TESTS

	Carbon	Phosphorus	Sulphur
Army cast steel.................	...	...	...
Navy C..........................	...	0.06	0.07
ASTM Class A..................	0.30 Max.	0.06	...

* For basic Steels, Phosphorus to be 0.05 per cent.

† Bend to be 1 x ¾-inch, corners rounded to 1/16-inch radius, bent to a radius of 1 inch.

‡ For army No. 3 steel, if carbon is below 0.35 per cent, phosphorus may be 0.06 per cent and sulphur 0.08 per cent.

steel in other respects and that he was capable of meeting the physical specifications of the steel in a satisfactory manner.

Lloyd's Tests Are Severe

Turning to the physical specifications, there should be no great difficulty in meeting the tests for Army No. 1 steel and for Navy B steel with properly made castings of about 0.25 per cent carbon and from 0.60 to 0.80 per cent manganese. These tests should be met by any good cast steel of this composition annealed in the usual way by heating several hours at about 1650 degrees Fahr. and cooling slowly in the furnace. The Lloyd's Register specifications for ship and engine castings are apparently intended to suit a steel of about the composition just given, although the bending test which they specify on a ¾-inch thick bar is considerably more difficult to meet than that of the army and navy or the American Society for Testing Materials. The fact that Lloyd's also calls for a maximum as well as a minimum in tensile strength might prove embarrassing in some cases, but the writer understands that Lloyd's and the American Bureau of Shipping, whose specifications are closely parallel to Lloyd's, are not standing rigidly on the maximum specifications for tensile strength, provided the steel has sufficient toughness as exhibited by the extension and bend. The writer has not had experience with recent tests made under Lloyd's Register, so that he is not able as yet to form any judgment as to the severity of the drop tests and hammer tests specified by Lloyd's bureau. The hammer test, which consists in slinging the castings in the air and hammering them all over with a 7-pound sledge does not sound to him very formidable, as it must be a very poor casting indeed that would develop any cracks or flaws under this test, especially if the annealing has been properly carried out. The drop test, which calls for dropping either one end of the casting or the whole casting on the hard ground, would seem at first sight to present no difficulties to the foundryman except the inconvenience of carrying out the test and the possibility of bending the castings out of shape. No doubt members who have had experience with these tests can contribute interesting opinions as to the value and difficulty of the test.

The physical specifications for medium steels, including Army No. 2 and Navy D, should be met with steel of about 0.35 per cent carbon and from 0.60 to 0.80 per cent manganese, but more trouble will be met with in the case of the navy steel as it calls for very considerably more strength and elastic limit than the soft steels and at the same time calls for the same extension, contraction and bend as that specified for Navy B. In the majority of cases the writer would recommend the use of a double annealing, such as will be described later, for Army No. 2 and especially for Navy D.

The hard steels, Army No. 3 and Navy A, are usually made of about 0.45 per cent carbon and from 0.60 to 0.80 per cent manganese, and steel of this composition properly annealed should meet the specifications in a majority of cases. For this class of steel the double treatment is even more to be recommended than for the medium steels.

The two specifications for special steels are apparently intended to be filled with nickel steel. The writer has had no experience in the manufacture of castings to meet these tests and is not prepared to state what difficulties would be encountered in executing orders to meet these specifications, although he has information of one foundry which is making steel from the acid open-hearth furnace to meet Navy F specifications. This foundry is using steel of about 0.25 per cent carbon and 3 per cent nickel and is using a double treatment somewhat similar to that described further on, with the exception that the second heating is at a considerably higher temperature than that advocated by the writer.

How to Meet Navy F Specifications

In all fairness the writer feels he should say that if he is called upon to make steel for Navy F specifications he will use a special composition of steel with rather high manganese in proportion to the carbon, and will try to be allowed to heat-treat these castings by quenching in water or oil and reheating. This method of heat treatment is prohibited in the specifications but as the writer has had long experience in carrying it out he believes that it would be possible to persuade the authorities to allow him to use it, and that he would be able to meet the

specifications on all castings where oil quenching is possible. On castings too heavy or too complicated to permit of oil quenching he confesses he would be somewhat at a loss to know just how to meet these specifications with certainty, and hopes that the discussion of this paper will shed some light on this point.

It is difficult to over emphasize the importance of three principal factors, the neglect of which will cause the foundryman trouble in meeting these specifications. The first is that the steel must be properly made and thoroughly deoxidized, so that it will be quiet in the ladle and set sound in the castings and test bars. The steel must be made carefully, and usually the tonnage turned out is reduced on account of the slower and more careful furnace practice that must be followed. The second is that as much care, or even more care, must be taken in molding and pouring test bars as is taken with the castings. It seems a strange freak of human nature, yet foundries which are not familiar with specification work will in a great many cases be extremely careless with the designing, molding and pouring of the test pieces, in spite of the fact that the tests are not easy to meet, and are to be met not on the castings themselves but on the test bars. A little experience with heats lost because good test bars could not be turned up from the test coupons provided usually awakens the foundryman to the necessity of taking great pains with his test bars and coupons.

A number of designs of test coupon are used in different foundries, but the principle in all of them is to make sure that there is sufficient metal provided in some form of sink head or enlargement of the upper part of the coupon to make the lower portion perfectly sound and free from blow holes. The test bar or bars are generally cut, of course, from the lower part of the test coupon.

Care in Heat Treatment Demanded

The third point which has to be very carefully watched in the manufacture of these specification steels is the annealing or heat treatment.

The writer had a recent experience with a good friend in the foundry business who used a somewhat unusual chemical

composition for Army No. 3 cast steel at the writer's suggestion. He did not for some time have very good luck with the tests, stating that the steel was "wonderful when it was good and rotten when it was bad". The writer at this time was very busily engaged in finding out why a few heats of steel which he had made could not be induced to pass these specifications and did not have time to pay a visit to his friend who was struggling with Army No. 3. After a month or two he saw the friend, who informed him that he had traced practically his entire difficulties to the heat treatment, and that he was then passing Army No. 2 and No. 3 specifications practically without rejections.

Whatever annealing and heat treatment practice is followed, it is absolutely essential to make sure that the castings are subjected to the proper degree of temperature for a proper length of time. To do this it is not sufficient simply to have a pyrometer in the furnace read the temperature desired, because the pyrometer may not be indicating the temperature of the entire furnace, and for that matter the castings in the furnace may not have all reached the required temperature at the same time that the pyrometer did. The writer would hate to try to pass army and navy specifications with an annealing furnace so constructed as to make it impossible to look at the castings and judge their temperature by eye. If the castings are easily seen through a peep hole, it is possible to make sure that the color of the castings is the same as the color of the place in the furnace where the pyrometer is located and so avoid improper heating of the castings.

Annealing Practice

For what might be called old fashioned annealing of the average casting of average size, the writer believes that the steel should be heated to about 1650 degrees Fahr. for a period of at least two hours, and better for four hours. It is definitely known that a certain length of time is required for proper annealing after the castings are actually hot through at the desired temperature. For castings of average size it is not necessarily true that the annealing requires as much as four hours after the castings are hot, but from an experience of

some years the writer has come to the conclusion that it is better to use too long than too short a time, especially as too short a time may mean that some of the castings do not even reach the desired temperature.

After the four hours heating at 1650 degrees Fahr. the castings may be cooled slowly in the annealing furnace, and if the chemical composition has been correct, this treatment should give the steel a sufficiently good anneal to pass any of the specifications that have been discussed in the foregoing. The writer, however, very much prefers to use a double treatment which consists in cooling the castings as rapidly as possible in air and afterward reheating them to a temperature of between 1200 and 1300 degrees Fahr., the exact temperature depending on the carbon and manganese of the castings. This second heating at a low temperature must in most cases be continued for a considerable length of time. The writer uses up to six hours at these temperatures in cases where the carbon and manganese are somewhat high, so that the principal thing to look out for is the extension and contraction rather than the strength. It might seem possible with this double treatment to use a somewhat higher temperature for the second heating and hold the castings at that temperature for a shorter period. It has been found, however, that for the best results, the temperature on this second heating should not exceed 1300 degrees Fahr. because to exceed that temperature does more harm than good. The writer has published data on this point at various times and the only object of referring to it here again is because he has run across several cases lately where two heatings are used and the second heating is so high that apparently better results would be secured by heating only once and cooling slowly in the furnace.

In the majority of cases where this double annealing is practiced it is better to cool in the furnace after the second heating, but this is not essential, since only very slight strains are set up in the castings if they are cooled in air from 1300 degrees Fahr., and the air cooling from this temperature does not affect the test bars enough to show up in the tensile test.

One of the most vexatious features in the production of castings to meet these specifications is the great number of

tests that have to be made on each heat of steel. The army calls for one tensile test from a coupon cast attached to each casting over 200 pounds in weight, and the same number of tests from a separate coupon for each heat of castings weighing under 200 pounds. Under the stress of war conditions this specification is not adhered to rigidly, and in fact it is almost essential that it be modified in cases where a great many castings are made on one heat which would usually call for a test on each casting under the strict letter of the specifications.

The navy calls for one tensile and one bending test from a coupon attached to each casting over 200 pounds and for two tensile and one bending test from a separate coupon for each heat of castings weighing under 200 pounds. In some cases the inspectors have demanded tests from two or three castings weighing over 200 pounds on a heat and have insisted that the two tensile tests from a separate coupon to cover the light castings on the heat should be taken from different coupons. When this specification is rigidly adhered to, the number of tests demanded from a shop making heavy heats of medium weight castings is so great that the job of taking care of the tests becomes a very onerous one. Having had experience with only a few orders of navy castings the writer is not aware just what modification may have been made in this specification in other shops.

For comparison with the requirements just enumerated it may be stated that the American Society for Testing Materials calls for one test from each annealing furnace charge of castings, except when several casts of steel are represented in the annealing furnace charge. In this case one test is required for each cast in the annealing furnace. Castings under 500 pounds, or castings of such design as to make it difficult to attach a coupon, may be represented by a coupon or coupons cast separate, in which case one test is required for each cast of steel. In order still further to simplify the testing of small castings a clause is inserted allowing the testing of small or unimportant castings by breaking up three or more castings from the heat, those castings to exhibit a proper degree of toughness and freedom from defects.

Lloyd's Bureau of Shipping requires one tensile and one bending test from a coupon attached to each casting and the specifications state that for larger castings two tensile and two bending tests will be required, and that if more than one melt of steel goes into the casting four tensile and four bending tests will be demanded. Not having executed any orders for them yet the writer is not aware how rigidly the inspectors are instructed to stand on this specification.

This is hardly the place to deal with the difficulties which the foundries encounter in keeping everything going straight, especially when a great number of small castings have to be kept together by heats until they are all finally inspected. This is perhaps one of the most vexatious features of the manufacture of these castings, but among the readers of this paper probably are numbered a great many men who have been all through it, so that the writer feels free to do no more than refer to it in passing.

The foregoing remarks have been rather hastily prepared under the stress of present-day conditions in a foundry engaged in the manufacture of specification steel and are by no means intended as either a thorough or an authoritative discussion of the subject. It is hoped, however, that enough has been said to give a general outline, and that the discussion will bring out many points not covered in the paper.

Meeting Specifications for Army Ordnance Steel Castings

By Capt. E. R. Swanson, Washington, D. C.

You gentlemen are familiar with the fact that requirements as to physical properties for the three principal grades of steel castings for the ordnance department are now the same as those of the American Society for Testing Materials. The chemical properties also are identical with the American Society for Testing Materials specifications, except that greater latitude is given in the case of sulphur. For reference the figures are given as follows:

Cast Steel	Elastic limit per sq. inch	Tensile strength per sq. inch	Elongation per cent in 2 inches	Reduction of area per cent
No. 1........	27,000	60,000	22	30
No. 2........	31,500	70,000	18	25
No. 3........	36,000	80,000	15	20

The time at the writer's disposal does not permit the extended detailed observation for presentation that the subject merits, and in fairness to the foundrymen, much matter available could not be published and accredited.

Practically all steel castings for ordnance purposes are made by the acid open-hearth, electric furnace or side-blow converter.

Two Methods Pursued

The problem of meeting requirements has resulted in the establishment of two methods. One makes use of combinations of low carbon and high manganese; the other, high carbon and normal manganese. The first method is of especial value to the converter shop.

The chemical analysis followed by a shop getting 98 to 100 per cent acceptances on first test for the No. 2 steel, using

the converter, is as follows: Carbon, 0.26 to 0.30 per cent; manganese, 0.65 to 0.75 per cent; silicon, 0.26 to 0.35 per cent; sulphur, 0.07 per cent, and phosphorus, 0.05 per cent.

This steel is annealed by heating to 1650 degrees Fahr., soaking four hours at that temperature and cooling slowly in the furnace. This shop is not making any of the No. 3 grade steel.

One shop is working on orders various items of which call for No. 1, No. 2 and No. 3 grades. Their practice is to fill them all with steel of the No. 3 grade, using the converter process. Their chemical analysis is as follows: Carbon, 0.38 to 0.45 per cent; manganese, 0.75 to 0.85 per cent; silicon, 0.40 to 0.50 per cent; sulphur, 0.04 per cent, and phosphorus, 0.05 per cent.

This steel is annealed by heating to 1575 degrees Fahr., soaking four hours at that temperature and cooling slowly to 700 degrees Fahr. in furnace, at which temperature castings are pulled out into the air. This practice results in 95 per cent acceptances on first test.

Another Analysis

Another company using converters for the No. 3 grade, works to the following analysis: Carbon, 0.25 to 0.30 per cent; manganese, 0.90 to 1.00 per cent; silicon, 0.30 to 0.35 per cent; sulphur, 0.07 per cent; and phosphorus, 0.05 per cent.

This steel is annealed by heating to 1700 degrees Fahr., soaking four to six hours at that temperature and cooling in air. It is then drawn by heating to a temperature of 900 to 1100 degrees Fahr., depending on the carbon, and cooling slowly in furnace. This firm deals with the No. 2 grade steel in much the same manner except that the carbon in this case ranges between 0.24 and 0.28 per cent, with manganese between 0.85 and 0.90 per cent. The castings are annealed at 1750 degrees Fahr. with subsequent draw.

A most successful company using the electric furnace for the No. 3 grade, works to a chemical analysis as follows: Carbon, 0.25 to 0.30 per cent; manganese, 1.10 to 1.30 per cent; silicon, 0.35 to 0.45 per cent; sulphur, 0.05 per cent, and phosphorus, 0.04 per cent.

Castings are annealed by heating to 1650 degrees Fahr. and soaking three to four hours at that temperature, cooling in the air, and then drawing at from 900 to 1100 degrees Fahr., cooling slowly in furnace.

Electric Furnace Analysis

Another company successfully meets the requirements for both No. 2 and No. 3 grades of steel by making only one grade, namely the No. 3, using the electric furnace. Their average analysis is as follows: Carbon, 0.38 to 0.42 per cent; manganese, 0.60 to 0.70 per cent; silicon, 0.25 to 0.35 per cent; sulphur, 0.05 per cent; and phosphorus, 0.04 per cent.

They anneal this steel by heating to 1650 degrees Fahr., soaking at that temperature for six hours, and cooling the castings slowly in the furnace four to six hours.

The chemical analysis followed by a company using the acid open-hearth which has had 100 per cent acceptance is as follows: Carbon, 0.42 to 0.48 per cent; manganese, 0.65 to 0.70 per cent; silicon, 0.25 to 0.30 per cent; sulphur, 0.04 per cent; and phosphorus, 0.05 per cent.

Their practice is to allow three hours heating, two hours soaking at 1650 degrees Fahr., and five to eight hours cooling in furnace.

A resume of the foregoing shows the manner in which requirements are being met by companies having from 95 to 100 per cent acceptances on the first test. The high percentage of acceptances shows that specifications are not excessive.

A very elaborate treatise could be drawn up on the subject of critical temperatures, length of annealing periods, etc. The critical point will vary according to the chemical analysis. You all know that to secure proper refinement of structure all parts of castings must be heated above the critical point and held long enough to permit necessary refinement. This period will vary according to the thickness of section.

Specifications Can Be Met

Disclaiming any desire to criticise equipment or methods in shops having difficulties, it is desired to make this point—that No. 2 and No. 3 grades are being made successfully and

commercially. In order to do this, two things are required: *First,* control of analysis of product, so that the castings will analyze within predetermined limits; and *second,* annealing equipment of such nature that the furnace can be brought up to the desired temperature at a predetermined rate with equal temperatures prevailing in all parts of furnaces at the same time.

Control of analysis is had by competent supervision assisted by suitable chemical laboratory equipment.

Control of heat treatment can be exercised by the use of properly designed furnaces, so constructed that uniform heating prevails together with proper circulation; and the installation of proper recording pyrometers equipped with sufficient thermocouples so that furnaces can be checked for cold spots.

The absolute fundamental in meeting the requirements of the No. 2 and No. 3 grades is proper chemical analysis, supplemented by accurate annealing or heat treatment.

An extreme illustration of what has been done in the past, in a shop not equipped to anneal small castings, follows: The practice was to wait until a heat was poured which left a heavy skull in the ladle. The castings were annealed (?) by throwing them in the ladle and leaving them until the skull was cold. It is to be expected that they would experience trouble.

Weaknesses Are Remedied

Most of the wideawake steel foundries have by this time discovered their weaknesses and have remedied them by installation of suitable up-to-date equipment.

Occasionally a heat is discovered that does not respond to proper heat treatment even though analysis is normal. An examination with the microscope will usually show the difficulty. Many companies are using the microscope as a daily check on their product. This is a refinement of practice that up to a short time ago prevailed in but very few foundries, but one of the many good things coming out of this world war is an improvement in the quality of steel castings that is really remarkable and of which the steel casting people can really be proud.

Discussion on Ordnance Steel

Mr. A. S. Hummell.—Our experience has convinced us that it is possible to make No. 2 and No. 3 steels successfully from converter metal, keeping within the chemical specifications laid down by the ordnance department. We find, however, that the product of the basic electric furnace is most satisfactory, and we are making all of our ordnance castings from 6-ton basic electric furnace steel. It is necessary to keep the carbon on the higher side of the composition, 0.45 to 0.50 per cent, in order to overcome the softer qualities of electric steel, and it is our opinion that a better and sounder steel is obtained than the converter process produces.

Our electric steel is of the average composition of carbon, 0.44 to 0.48 per cent, with manganese 0.60 to 0.80 per cent, and sulphur and phosphorus under 0.030 per cent. A typical result is as follows:

Tensile Strength, pounds	85,700
Elastic Limit, pounds	38,800
Elongation, per cent	22
Contraction, per cent	35

The composition of steel which gives the foregoing properties when annealed is as follows: Carbon, 0.46 per cent; silicon, 0.30 per cent; manganese, 0.65 per cent; sulphur, 0.022 per cent, and phosphorus, 0.019 per cent. This steel is annealed at 1650 to 1700 degrees and slowly cooled.

The foregoing compositions give satisfactory results and meet the specifications uniformly. Not being equipped for heat treatment, we consequently have annealed all our castings. No heat treatment that is air or water hardening and drawing is performed.

Referring to inspection, it is our experience that the sub-inspectors endeavor to co-operate as much as circumstances permit. Castings may sometimes be condemned because of lack of experience or freedom of judgment, and when so rejected or temporarily held up considerable loss of time elapses before

final decision is received from the commanding officer. This is an exceedingly undesirable condition and if possible should be corrected by placing a competent person on the job to settle points or differences immediately. It seems to us that frequently castings that are good castings may be rejected because of unduly rigid inspectors.

We have found it necessary to install additional clerical assistance. The necessity for keeping melts and annealing heats together, properly identifying the different castings, and rendering detailed records, is highly important. The requirements as regards furnishing a casting free from annealing scale present considerable difficulties, and the re-sandblasting and chipping of tightly adhering scale tends to delay production materially. It would seem that scale which adheres tenaciously might well be allowed to remain, though one must admit it does not present a fine appearance. In general we have been able to meet the ordnance specifications as regards chemical and physical requirements without undue trouble.

MR. R. F. FLINTERMANN.—On grade No. 2 we have been using 0.35 to 0.40 per cent carbon steel. On grade No. 3 we have been using 0.40 to 0.45 per cent carbon steel. In both cases we have endeavored to keep our manganese between 0.70 and 0.80 per cent. On all heats where the analyses are as given above, we are able to meet the physical requirements merely by giving such castings a straight anneal of four hours at 1575 degrees Fahrenheit, allowing the castings to cool in the oven.

Wherever castings fail to meet physical requirements after this treatment, a check analysis is made on such heats, and in all cases where carbon or manganese is found to be lower than shown above, we subject the castings to a second anneal at 1575 degrees Fahrenheit, and then allow them to cool in air. We further subject these castings to a draw in temperature varying from 900 to 1200 degrees Fahrenheit, all depending on the analysis of the particular heat so retreated, allowing the castings to cool with furnace after having been drawn as above.

By applying this method, our records show that 60 per cent of the material passed upon first treatment; 38 per cent passed on second treatment; the balance of 2 per cent represents the actual loss of heats, which could not be made to meet

physical requirements. As regards this 2 per cent loss, we might explain that this loss consisted entirely of heats in which carbon and manganese exceeded the limits, and on such heats no amount of redrawing seemed to bring them within proper limits as regards reduction and elongation.

We might add further that part of this loss was due to carelessness in this foundry as regards attaching proper test bars for each heat. It was necessary, therefore, in a few cases to cut bars from the castings themselves, and since the castings were small it was difficult to obtain bar of proper size for testing.

We might add just a word or two as regards the inspection of the castings themselves in our plant. While there were some misunderstandings at first, such misunderstandings were more or less completely done away with after the foundry and inspectors became more familiar with different patterns.

The rejections in our foundry on army work was somewhat higher than on commercial work, as might be expected, but on the other hand, this increased loss was counterbalanced by the extremely low percentage of returned castings from machine shops after machining.

Mr. T. S. Quinn.—It is not well to indulge in too sweeping generalities in regards to making No. 2 and No. 3 steel for the army, as the process employed and the equipment available, must dictate the practice of each foundry.

I would like to emphasize this point, however, to foundries who are not at present engaged in the production of special heats to meet certain specifications for the army and navy, and that is that they must be prepared to augment their equipment with additional facilities, if they wish to keep their tonnage up to their rated capacity. The greater the percentage of special heats to total melt, the slower do the heats move through the foundry, and the less tonnage produced in a given length of time, and the point that I wish to make, and that should be of interest to some, is that this condition should be discounted in advance, instead of waiting for the disappointment that must follow when difficulties are experienced in shipping the required tonnage.

Mr. C. S. Koch.—I had hoped when I heard that Capt. Swanson was going to have a paper that it would bring out something more in detail as to what each of you have done, and perhaps some reason given why you had taken the stand that you had. The work varies so greatly so far as the army is concerned that it has not wished to give out any specific instructions, feeling by reason of the different equipment, and perhaps by reason of the different methods of making steel, that all the army requires is to get the results, leaving the methods to each of you. Early in the year, when the army ordnance department started on that sort of thing, they were going to get up quite a detailed pamphlet and insist that every man anneal in about the same manner and make steel to certain chemical specifications. However, they stopped and went no further except to state that it shall be over the proper critical temperature. It is absolutely a matter of watching details of annealing, assuming that your carbon and manganese is in reasonable state. In other words, 0.18 per cent is too low to be safe.

Early in the year the matter of specifications for carbon came up again and it looked for a while as if carbon would be specified until we showed that some shops were getting away with No. 3 steel with 0.20 per cent less carbon than others. Therefore, it seemed wrong to specify anything of the sort, instead it is best to leave it to the foundries.

The Chairman, Mr. C. R. Messinger.—It doesn't make any difference whether you have an electric furnace, converter, open hearth or crucible, if you will take certain precautions in connection with your practice and follow out the details you can make No. 3 and No. 2 steels successfully.

Mr. G. R. Hanks.—You mean that the various processes don't seem to make very much difference?

The Chairman.—My personal opinion is that there are companies not doing what they should and that they should go about it and at least try to make ordnance steel because other companies with the same equipment are very successful.

Mr. C. S. Koch.—We have not kept any definite records in regard to getting heats through on the first and subsequent tests. We can't tell exactly which foundries are the best or

which process succeeds best or anything of that sort. However, we have an idea, a general idea perhaps. In my personal opinion the two foundries that have won out the best are one electric shop and one converter shop. A very small amount of all this work for the ordnance department is being made by open-hearth process. In other words, the number of open-hearth foundries working on this is so small it would hardly be fair to bring that process into any comparison. I think it is the plant and the men behind the plant that does it.

In regard to what Mr. Messinger has said concerning certain shops doing better, the difficulty in the early days of all ordnance work was that the specifications required 0.05 and 0.07 per cent phosphorus and sulphur respectively. Converter shops unless they had a very good coke supply couldn't meet these requirements. However, more recently some of the converter shops have taken on this work since the specifications were changed from 0.05 and 0.07 per cent to 0.06 and 0.08 per cent, respectively.

THE CHAIRMAN.—There seems to be some division of opinion with reference to the process to be used and also with reference to the method of annealing. This opinion appears to be divided into schools. From what little I know about it, it seems that all methods are successful providing the details are watched. There is one plant that has had conspicuous results with the electric furnace. It would be of interest to this meeting to know a few of the details in connection with this work. We will be very glad, therefore, to hear from Mr. Quinn.

MR. T. S. QUINN.—I think I can say that we follow what I believe we can call the lines of least resistance in making No. 2 and No. 3 steel. We get pretty good results. Although we make only electrical steel, I am not prepared to say that this is the only reason we have good results.

I am rather inclined to believe it is due to the fact that we pay a good deal of attention to details in annealing such as checking pyrometers, etc., not only seeing that they are all right, but also keeping the heat uniform over night. I believe this has more to do with it than merely the matter of process. I can say for the benefit of those who are not acquainted with the electrical process, that we started with low carbon and high

manganese and got very good results. A good many people use a single anneal, which is rather surprising to me. I rather thought it was usual to double anneal.

THE CHAIRMAN.—Mr. Quinn, approximately how many heats go through on the first anneal of No. 3 steel?

MR. QUINN.—I should say that over three failures a month would be unusual where the output is No. 2 and No. 3 steel. We find by looking into it that we generally can trace the trouble to the heat treatment, although there is an occasional heat that falls down on analysis.

THE CHAIRMAN.—Mr. Quinn represents one school in that he has nothing but electric furnace equipment. There is another plant which is represented here that originally, as I understand it, worked on the double annealing basis and had very good results. I want Mr. Inglis to tell us briefly a little something about his process. Mr. Inglis is from the Milwaukee Steel Co. of this city.

MR. INGLIS.—At first we gave two treatments and obtained fine results but we were called upon for more tonnage than we could supply and we needed more ovens. We finally had to come to one treatment and we obtained the same result with No. 2 and No. 3 steel. We treat our steel by bringing it up to about 1525 Fahr., holding it there from 3 to 3½ hours, then letting it cool with a closed oven, coming down to between 800 and 900 degrees and then drawing it out. We make four to six heats a day, running every day in the week.

THE CHAIRMAN.—How many would not go through on the first trial?

MR. INGLIS.—Out of about 2,000 heats I don't think we have put six heats back into the oven to be retreated.

THE CHAIRMAN.—Gentlemen, Mr. Inglis has brought out the point I wished to bring before this meeting, that it doesn't make any difference if you have an electric furnace plant or any other kind of plant, if the plant is run right you will get the results.

A MEMBER.—Has it been demonstrated that the electric furnace must run higher in carbon to meet No. 3 specifications than the converter?

Mr. C. S. Koch.—You will find that in any process some shops are getting along with 0.30 per cent carbon while others require 0.50 per cent. The same applies to converter process, but not over such a wide range. In other words, with the electric furnace, some foundrymen run from 0.30 per cent to 0.50 per cent to get No. 3 steel and others with the converter anywhere from 0.30 per cent to 0.40 per cent and get No. 3 steel. My personal opinion is there isn't very much difference, but both the electric furnace and the converter can run more carbon than the open hearth.

I want to tell you a little about our work in connection with specifications.

The first thing we endeavored to do, was to get a uniform specification for No. 3 Navy, Army and American Society of Testing Materials steels.

As Captain Swanson has said, after two or three minor changes, the army eventually made sufficiently radical changes until now the army specifications are practically the same as those of the American Society of Testing Materials. The other committee which Mr. Jamison worked hard on and which was not successful was the navy. We think the army did well. After the conferences were held, orders were issued immediately and sent broadcast. In the case of the navy, its conferences were held last August and the best I could do up to the time I left Washington Oct. 4, was to get a proof of the new specifications which are not yet in operation. Some of the paragraphs have been rewritten. The principal one, I think, with which the committee was most pleased was the one in which they got another class in the navy specifications which will help out materially.

The Chairman.—We have a letter from Mr. L. E. Thomas, chairman of the war service committee of the steel foundry industry which I would like to have read. This letter is as follows:

"If the opportunity presents itself you might state for me as chairman of the war service committee of the steel foundry industry that the foundries greatly appreciate the co-operation of the officials of the army ordnance department in revising the specifications to meet the requirements of the foundries, and I

trust Captain Swanson's paper and the discussion on it will develop the fact that the revisions in the specifications have made it possible for the foundries to furnish castings to meet the army's requirements."

Mr. John Howe Hall.—Since writing my paper my attention has been called by Mr. Hodson of the Electric Furnace Construction Co., to the following statement in the paper, "This makes it possible to turn out army No. 1 and No. 2 steel from either acid open hearth, acid electric, basic open hearth, etc." The exact wording of this sentence seems to imply that the basic electric furnace is not suitable for No. 1 and No. 2 steel. Of course, as the basic furnace produces steel lower in phosphorus and sulphur than the acid furnace, the basic furnace is quite as suitable as the acid for turning out the army No. 1 and No. 2 steels.

The Chairman.—There is one thought which I believe has not been brought out yet and that is the mechanical side irrespective of the chemical side of the problem. I refer to the advantage that accrues from doing the same thing regularly and seeing that it is well done. We made a small quantity of specification steel and had reasonably good results. But we had too good an opinion of ourselves. Later we had an opportunity to take some very large orders for No. 3 steel so we took them and our problem was to run eight 3-ton heats a day, and I will say we had a lot of trouble. We finally ended by putting up two tents, one on each side of the plant and that is where most of our steel went. The trouble was not with our steel, nor was it with the annealing, but we tried to do too much in too short a time and got into a terrible jam. So much so that Mr. Koch came out to talk it over with us, and we started all over again. We put a system in for handling the heats, for keeping them together and made some set rules as to what we would do and what we would not do. The problem gradually ironed itself out; we are now making a large quantity of No. 3 steel and are not having any trouble.

Our results up to Sept. 20 were 86 heats of No. 3 steel of which 80 went through on the first trial, and yet during the month of January, I think that we cast somewhere near 50 heats and I don't believe we got 10 through on the first anneal.

We eventually got most of them. The only thing I would emphasize would be the question of details and I claim it is not the furnace, not absolutely the analysis, not absolutely the annealing, but it is doing practically the same thing day in and day out and getting the plant systematized.

Preliminary Report on Manufacture of Semisteel Shell in American Foundries

Prepared by H. Cole Estep Under Auspices of U. S. Government Semisteel Shell Committee on Manufacturing Practice

Our tremendous war activities have so thoroughly absorbed the energies of our great steelmaking industry, which is now producing at the rate of 40,000,000 tons a year, that the government, acting through the ordnance department, has called upon the foundrymen of America to turn their facilities to direct account by manufacturing millions of cast semisteel shell. Thus we find that in the field of ammunition supply, to a degree at least, what has been termed the war of ingots is giving way to the war of castings.

It is the purpose of this report to assist in the successful execution of the government's semisteel shell program by presenting as briefly as possible an outline of approved methods of manufacture on which foundrymen undertaking the production of shell for the first time may place reliance. Our foundrymen are leaders in the solution of difficult manufacturing problems involving large tonnages. But with one or two exceptions they have had practically no experience in shellmaking. There is a real need, therefore, for definite, accurate information on the semisteel shell problem. Fortunately we have available the experience of our French allies, whose experiments in this field antedate the war and whose operations on a large scale go back to 1914. Of even greater value to shops in the United States is the work both here and abroad of certain large American corporations, whose experience has been generously donated to the government and the industry in the present emergency, and in this connection special acknowledgment is made to the American Radiator Co. for its prominent part in the work.

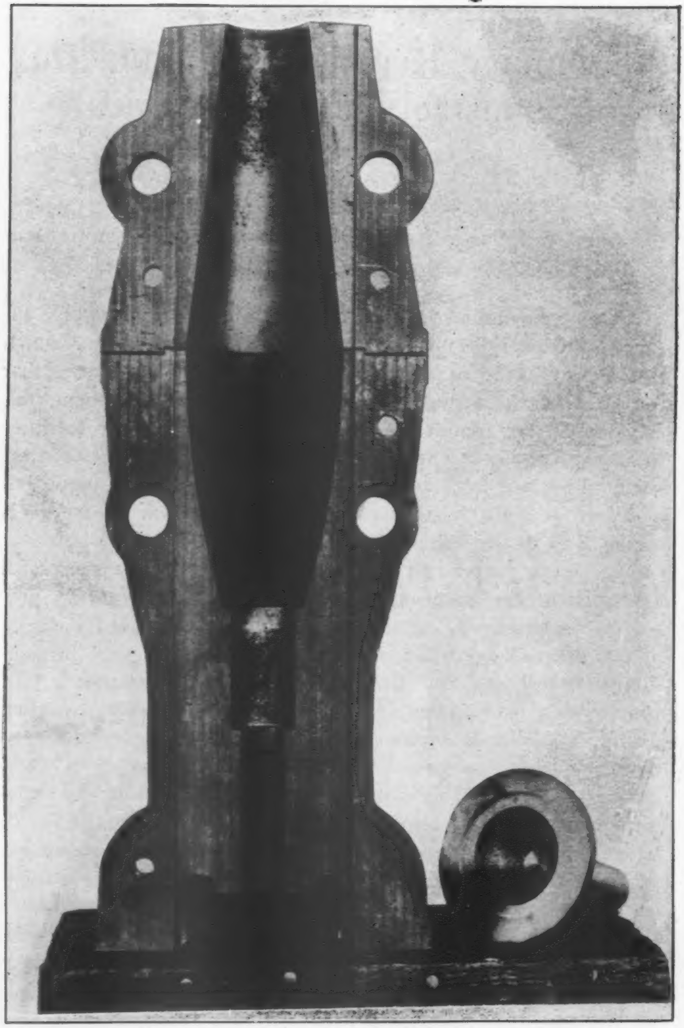


FIG. 1—IRON WORKING PATTERNS FOR CORE BOX SHOWING JOINT WHICH ALLOWS FOR MACHINING

This subject naturally divides itself into two parts, dealing respectively with the foundry and machine-shop problems involved in semisteel shell manufacture. The foundry problems deserve first consideration; also they involve matters, concerning which there is relatively little information available at the present time. The data to be presented covers primarily the production of 4.7-inch and 155-millimeter shell, although the production of 75-millimeter and 8-inch shell also will be touched upon. In addition, it is understood the government

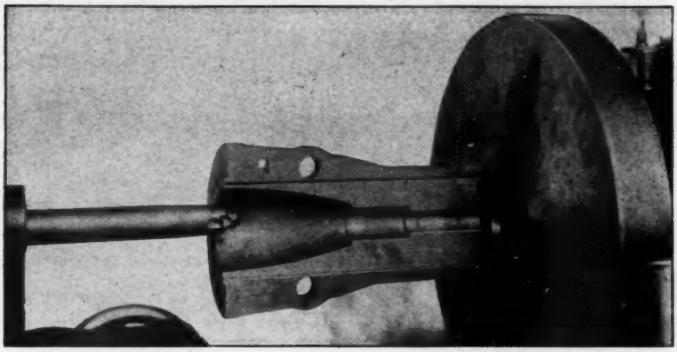


FIG. 2—TURNING INSIDE OF IRON WORKING PATTERN FOR CORE BOX WITH THE USE OF PROFILING ATTACHMENT—ONE HALF OF BOX REMOVED

expects to make contracts for some shell larger than 8-inch. As far as operations in the foundry are concerned, the methods are almost identical for the various sizes of shell, the principal variations from normal practice being encountered in the largest and smallest sizes. The 75-millimeter shell involves some problems peculiar to itself and the same is true of shell 8 inches and larger in diameter. The general methods of production are best explained, however, by dealing principally with shell of medium size, namely 4.7-inch and 155-millimeter, with suitable references to the special modifications in practice which may be necessary when turning out larger or smaller sizes.

The Background of the Problem

Although shell may be made satisfactorily simply by following the drawings and specifications, the intelligent manu-

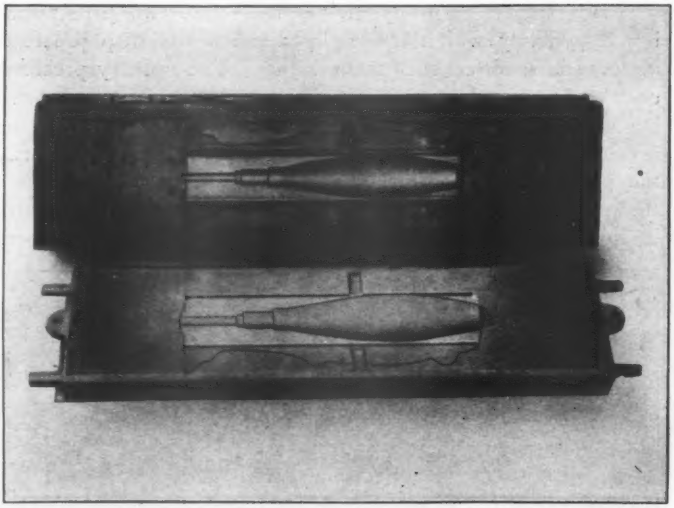


FIG. 3—IRON WORKING PATTERN FOR INSIDE HALF OF CORE BOX AND FINISHED HALF OF MOLD

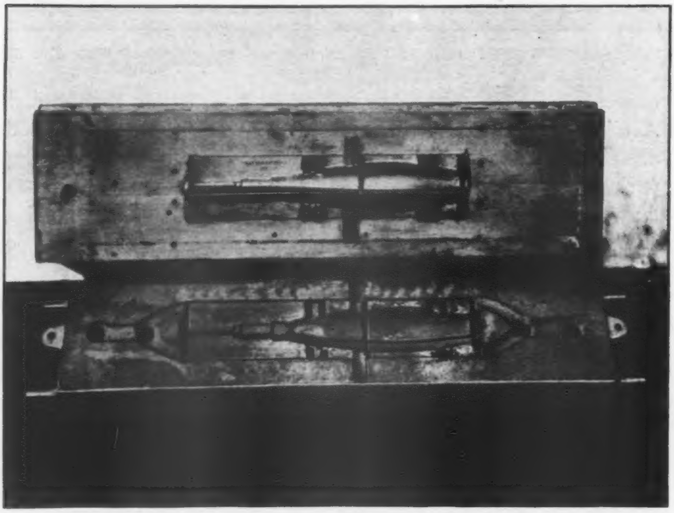


FIG. 4—IRON WORKING PATTERN FOR OUTSIDE HALF OF CORE BOX AND FINISHED HALF OF MOLD

facturer usually finds that he is able to do better work when he is familiar with the background of his problem, and in possession of the salient facts covering its history and practical application. At the risk, therefore, of repeating information which may be already familiar, a few remarks on

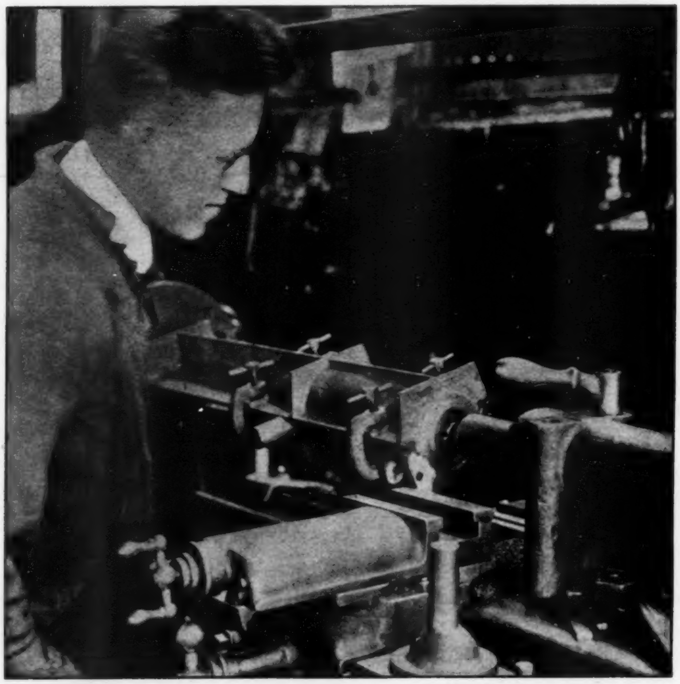


FIG. 5—TURNING END OF WORKING CORE BOX AND LOOSE PIECE TO FORM ROUND NOSE ON CORE

the history and uses of semisteel shell will be presented before taking up manufacturing problems in detail.

In a purely experimental way semisteel shell were made both in the United States and abroad prior to the war. The United States navy, it is understood, made experiments on the production of cast iron and semisteel shell in permanent molds, as well as in sand, as far back as 1910. Considerable work of

an experimental nature on cast ammunition, including semisteel shell, was also done before the war by Major Prache of the French army. As is also well known, the production of semisteel in the cupola for the manufacture of castings for various civilian purposes was brought to a high state of perfection in

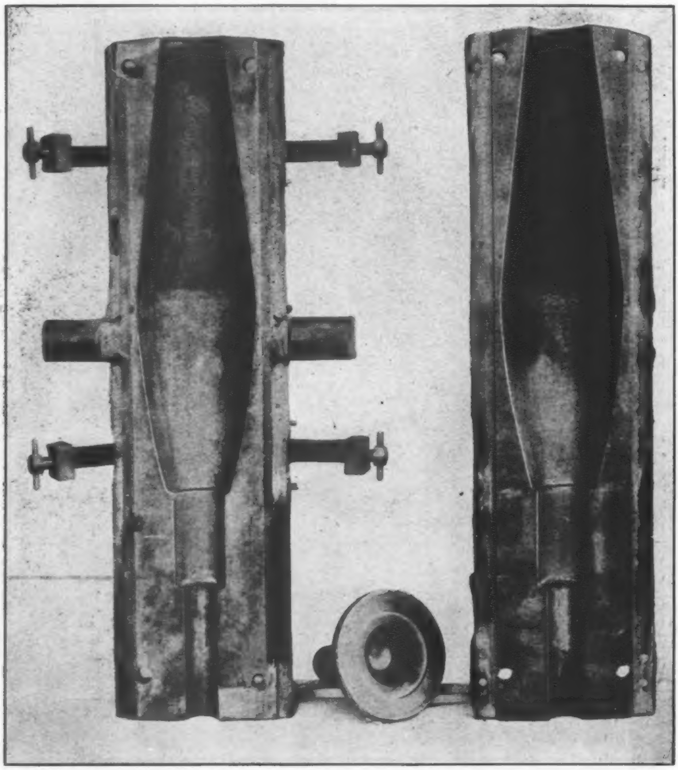


FIG. 6—CORE BOX OF TWO HALVES AND LOOSE PIECE TO FORM ROUND NOSE ON CORE

the United States prior to the war. In fact, as far as information on the metallurgy of semisteel is concerned, together with data on the corresponding cupola practice, the United States is in an extremely favorable condition to proceed with its cast shell program.

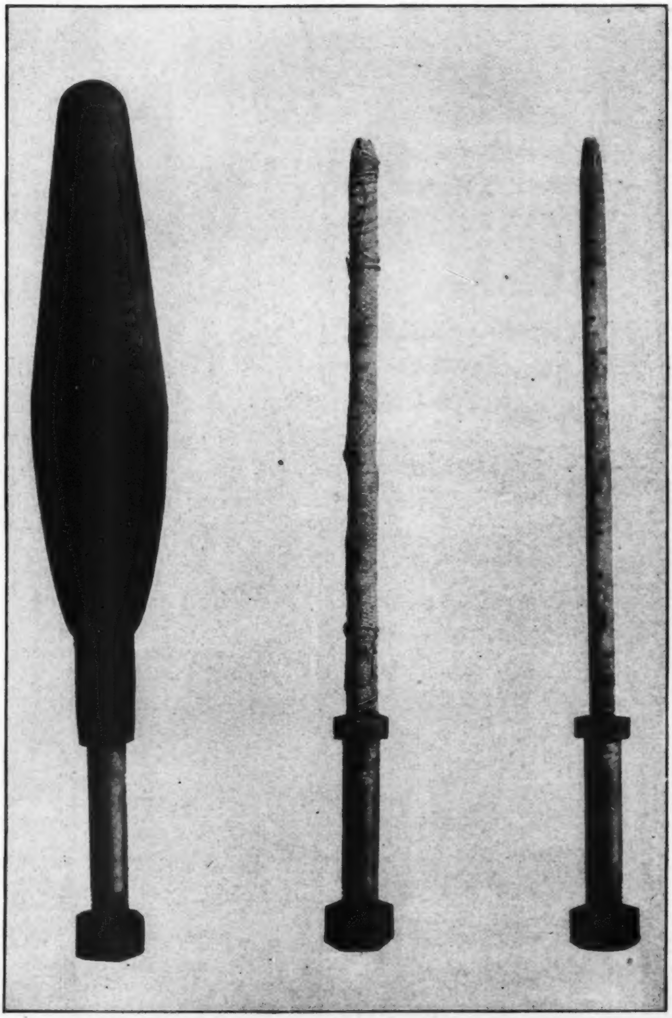


FIG. 7—CORE ARBOR PLAIN, CORE ARBOR WRAPPED WITH BURLAP, AND FINISHED CORE READY FOR THE FOUNDRY

FIG. 8—CORE TRUCK WITH CORES HANGING INSTEAD OF STANDING UP—TRUCKS ARE ALSO FITTED SO THAT CORES CAN BE DRIED STANDING UP

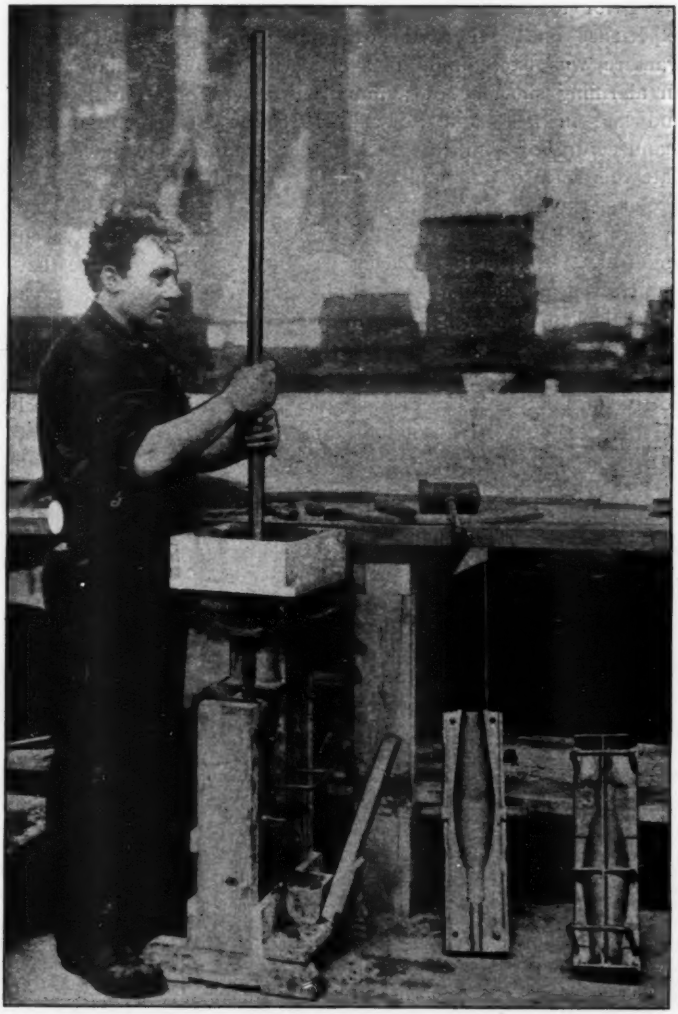


FIG. 9—RAMMING OF CORE BOX—TWO HALVES OF CORE BOX STANDING IN FRONT OF BENCH

Prior to the battle of the Marne, however, the fund of experience on the behavior of semisteel projectiles in actual warfare was exceedingly meager. Subsequent to that battle an alarming shortage of ammunition developed on both sides and late in 1914 and early in 1915 the French began the manufacture of semisteel shell on a large scale. Since that date this form of ammunition has been used extensively in the French army. A large amount of experience on the efficiency of semisteel shell under battle conditions, therefore, has been obtained. It has been found as a result of this experience that semisteel projectiles have a definite and recognized place in a well-balanced ordnance program.

A good semisteel shell should possess the following characteristics. It should be easily made as a cast-iron shell. It should have a firing efficiency approaching that of a steel shell. It should be absolutely safe. The latter point cannot be emphasized too strongly. The fact that the lives of our own men depend upon the reliability of the shell should never be overlooked. To this end the shell must be accurately finished. It must also have proper balance, correct fragmentation, and such rigidity that it will not plug the gun and cause an explosion. In addition the shells taken as a whole must be uniform. The fiftieth shell fired in a given action should be just the same as the first one.

Efficiency and Safety Factors

The efficiency of a semisteel shell depends upon the resistance of the envelope when the projectile arrives at the target, upon the explosive ratio and the fragmentation. The explosive ratio is the ratio of the weight of the explosive contained in the shell to the total weight of the loaded and primed shell. Against earthworks it has been shown by numerous experiments that the effects of bursting are nearly independent of the envelope and depend only upon the weight of the explosive. On the other hand the envelope should not break due to shock on arriving at the target, as this would cause a misfire or an incomplete burst. Shells fired against troops should explode so that as many fragments as possible weighing more than two grams are obtained. The requirements for safety

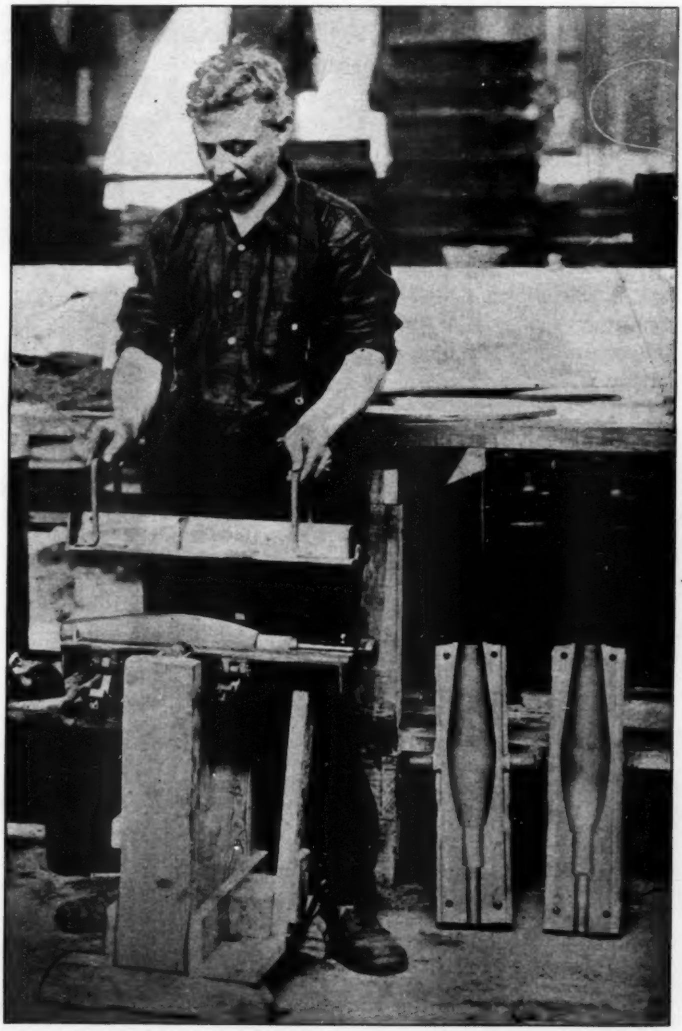


FIG. 10—CORE BOX IN A HORIZONTAL POSITION—DRAWING HALF OF CORE BOX

in handling and firing semisteel shell are that the envelope should resist the effects of shock at the moment of firing, that it should be airtight, and that the interior surface of the shell should be totally without unevenness or rough places.

With metal of proper composition the fragmentation of semisteel shell is satisfactory. French experiments have shown that a good semisteel shell bursts so that 55 per cent of the fragments weigh more than five grams.

Salient Features of Specifications

The complete United States government specifications for semisteel shell may be obtained from the ordnance department. These specifications contain certain features to which special attention should be directed.

The castings must be free from blisters, blow holes and cracks, except that slight imperfections on the outside of the shell in front of the position to be occupied by the rotating band may be allowed, provided they do not extend to a depth of more than one-quarter of the thickness of the wall and do not exceed ⅛ inch in diameter. The inside of the casting must be smooth. Each casting on being struck with a hammer must give a clear, metallic ring. All projectiles are subjected to a hydraulic test for 15 seconds. Shell 6 inches in caliber and smaller shall be tested at 4500 pounds per square inch. Projectiles larger than 6 inches in diameter shall be tested at 3000 pounds per square inch. All shell which show any leakage or a permanent expansion of more than 0.001-inch per inch of caliber will be rejected. Gas shell are given an air test in addition.

The specifications also provide that test bars shall be taken from the pouring ladle at each cast. These test bars must be cast in vertical baked sand molds from which they shall not be removed until they no longer show the color of heat. A round bar, 1¼ inches in diameter, machined to a diameter of 1.128 inches for a minimum length of 4 inches, is specified for the tensile strength test. The breaking strength shown by these bars must be at least 32,000 pounds per square inch. In addition bars 1½ inches square must be cast and subjected to an impact test. For this purpose the bar is sup-

FIG. 11—CORE BOX TURNED OVER AND CORE BEING REMOVED FROM BOX—RAP BOX LIGHTLY WITH STICK WHILE CORE IS BEING DRAWN

ported on two knife edges 6 inches apart and a weight of 25 pounds is caused to fall exactly on the middle of the test bar so supported. The test, it is specified, begins with the weight at a height of 12 inches and is repeated with the height of the weight increased by ½ inch intervals until the bar breaks. The height of fall when the bar breaks must be not less than 18 inches.

The tensile strength is made in a machine of standard construction with the tension grips so arranged that the bar is subjected to a straight pull. For this purpose grips arranged to screw over threaded ends of the bar are preferable. The impact test is made in a special machine, resembling a small pile driver, which will be described in detail later. The impact machines cannot be purchased and therefore in all probability they will have to be made by the shell contractors.

Dimensions and Weight of Shell

In order to calculate the quantity of raw materials necessary to turn out a given number of shell, as well as to determine the capacity of the apparatus used in the foundry for making the castings, the weight and dimensions of shells of various sizes must be known. The dimensions are shown on the official drawings of 75-millimeter, 155-millimeter, 4.7-inch and 8-inch shell respectively. The tolerances also are shown on these drawings. It will be noted that the 4.7-inch shell is 16.23 inches in length with a wall thickness forward of the bourrelet of approximately ½ inch. The outside diameter of this shell at the bourrelet is 4.16 inches. The core for the 4.7-inch shell, measuring from the outside of the nose, is approximately 15.4 inches in length with a maximum diameter of 3.655 inches. The core is bottle-shaped as indicated on the drawings, that for the 4.7-inch shell having a volume of 98 cubic inches. The adapter is screwed into the nose on a Briggs standard 1½-inch pipe thread.

The 155-millimeter shell is 22.7 inches in length overall with a diameter of 6.08 inches at the bourrelet. The walls are approximately 0.66 inch in thickness forward of the bourrelet. The adapter is screwed into the nose on a 1½-inch standard pipe thread. The core is approximately 21.5 inches

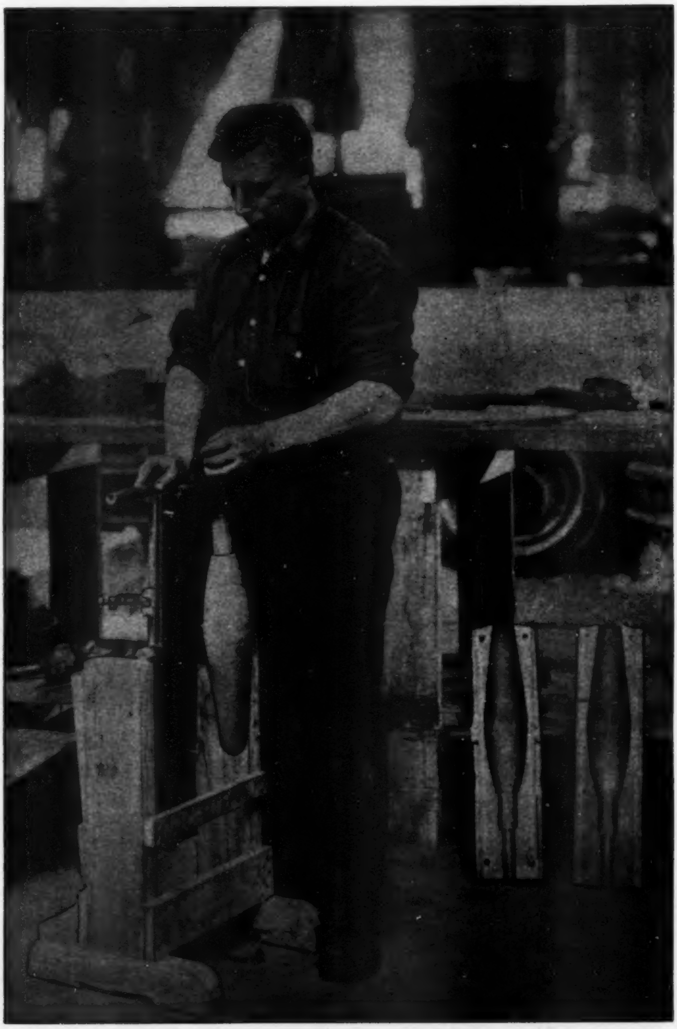


FIG. 12—ONE HALF OF CORE BOX AND CORE REMOVED FROM SAME

in length with a maximum diameter of 4.7 inches. The capacity of the shell, unfused, is 234.3 cubic inches. The overall and detailed dimensions of the 75-millimeter and 8-inch shell are shown on the drawings issued by the government.

It is important to know the weight of the shell at three stages of its manufacture, namely (1) rough as it comes from the sand with riser and nose attached, but with core removed; (2) as delivered to the machine shop with riser and nose cut off, and (3) after machining.

It also is advisable before considering the casting operations in detail to be familiar with the weights which it will be necessary to handle in the shop. For this purpose the following figures are presented. Most of the shell are molded on jarring machines in quadruplicate in cast-iron flasks. The quadruple flask for the 155-millimeter shell with the sand and patterns in place weighs approximately 1390 pounds. With the patterns for the four shells removed, the flask and sand alone weigh 1090 pounds, the weight of the sand being 290 pounds. The quadruple flask for 4.7-inch shell with patterns and sand in place weighs 900 pounds; with patterns drawn this weight is reduced to 700 pounds for the flask and sand alone. The weight of a 75-millimeter quadruple flask, rammed up with patterns in place, is approximately 450 pounds. This figure is reduced to 300 pounds for the net weight of the flask and sand.

Methods of Production

With the foregoing preliminary information in mind, we are now in a position to consider the foundry problems of the semisteel shell in detail. Generally speaking, three methods of casting these shell have been developed involving the employment, respectively, of green-sand, dry-sand and permanent iron molds. In each case dry-sand cores are used. For the present we will concern ourselves only with the green-sand method, inasmuch as it appears to be best adapted to conditions existing in the average American foundry.

One of the chief objects of the government is to obtain the largest possible number of shells in the shortest possible time. It is to accomplish this purpose that the green-sand

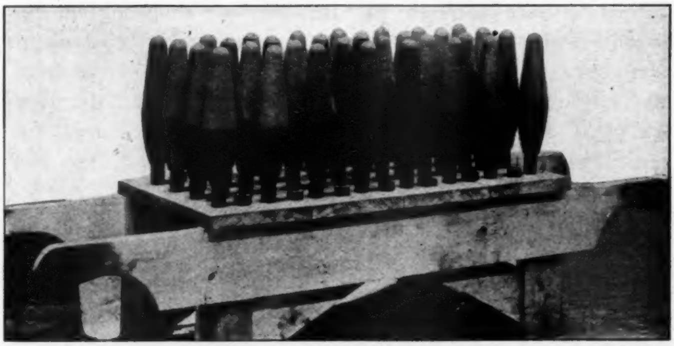


FIG. 13—RACK FOR CARRYING CORES FROM CORE ROOM TO THE FOUNDRY

FIG. 14—LOWERING CORE INTO MOLD—THE MOLDS ON FURTHER END OF FLOOR ARE COMPLETED

method is recommended for the average shop. Foundries already provided with a large amount of mold-drying equipment, such as certain automobile cylinder plants and pipe shops, may employ the dry-sand method to advantage. In the average plant, however, delays would be experienced in obtaining suitable mold-drying equipment, to say nothing of the lack

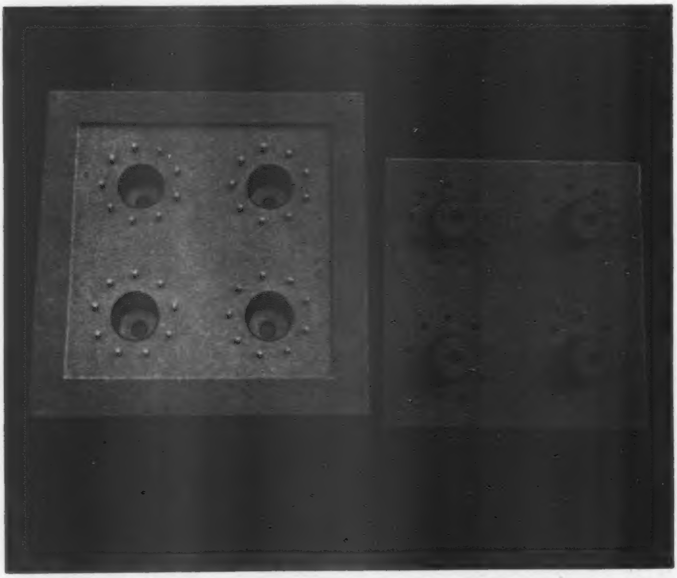


FIG. 15—BOX USED FOR MAKING CORE FOR COPE END DRY-SAND CORE—THIS CORE ACTS AS A STRAINER FOR THE IRON WHILE POURING

of experience in dealing with dry-sand molding problems. While the permanent mold also may be employed successfully, it is not recommended for the average foundry due to the fact that this process appears as yet to be more or less in the exceptional stage. Special experience and information is necessary if permanent molds are used. The dry-sand and permanent mold processes, however, will be described in considerable detail in subsequent reports. The green-sand process

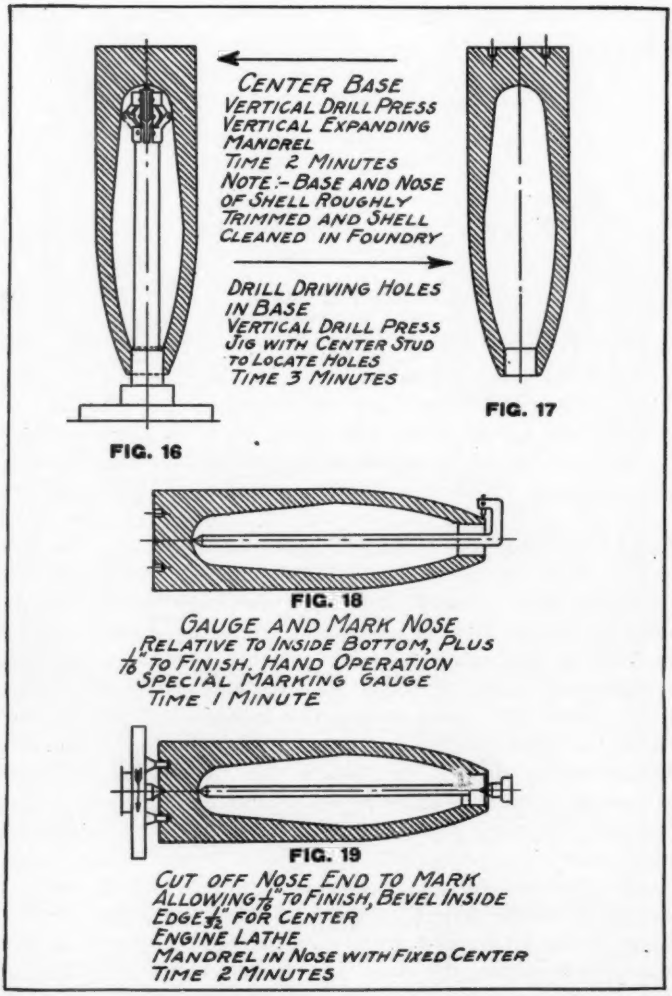


FIG. 16—CENTERING THE BASE. FIG. 17—DRILLING DRIVING HOLES IN THE BASE. FIG. 18—MARKING THE NOSE FOR CUT-OFF. FIG. 19—CUTTING OFF THE NOSE TO THE MARK

using dry-sand cores presents conditions with which the largest number of foundrymen are already familiar.

Recommended Procedure

For casting semisteel shell in green-sand molds, the following general procedure has been found satisfactory and is therefore recommended:

The flask, pattern and corebox equipment should be made of cast iron and be specially designed for the work at hand. Details of this equipment will be presented later. The shells are usually molded nose or ogive downward, there being four castings in each flask for shell up to 8 inches in diameter. The 4.7-inch and 155-millimeter shell also may be cast in single flasks where the shop equipment is not adapted to handling the heavier quadruple flasks. A coarse, open, lightly bonded molding sand should be employed. In most shops the maximum economy will be obtained by jar-ramming the molds on a plain jolt machine and in all cases the quadruple flasks should be so rammed. It is believed, however, that the single flasks for 4.7-inch and 155-millimeter shell can be profitably hand rammed, if suitable molding machine equipment is not available or obtainable. This statement is made in view of the relatively small amounts of sand which the recommended form of single flask contains. In neither case is the flask rolled over during the operation of making the mold. It should always be borne in mind, however, that the hand-ramming process necessitates the employment of men possessing relatively greater skill than those required for machine molding, and that under almost any conditions more uniform results will be obtained from jar-ramming. Since there are no projections or external pockets on the casting, it can be molded in a one-part flask, the entire casting being in the drag. The single flasks are usually made in two parts, split along the axis and bolted together. This is for convenience in molding the flask itself. The quadruple flasks are cast in one piece. In either case, a dry-sand pouring basin takes the place of the cope, and a drop gate of the strainer type is employed. The riser has the same diameter

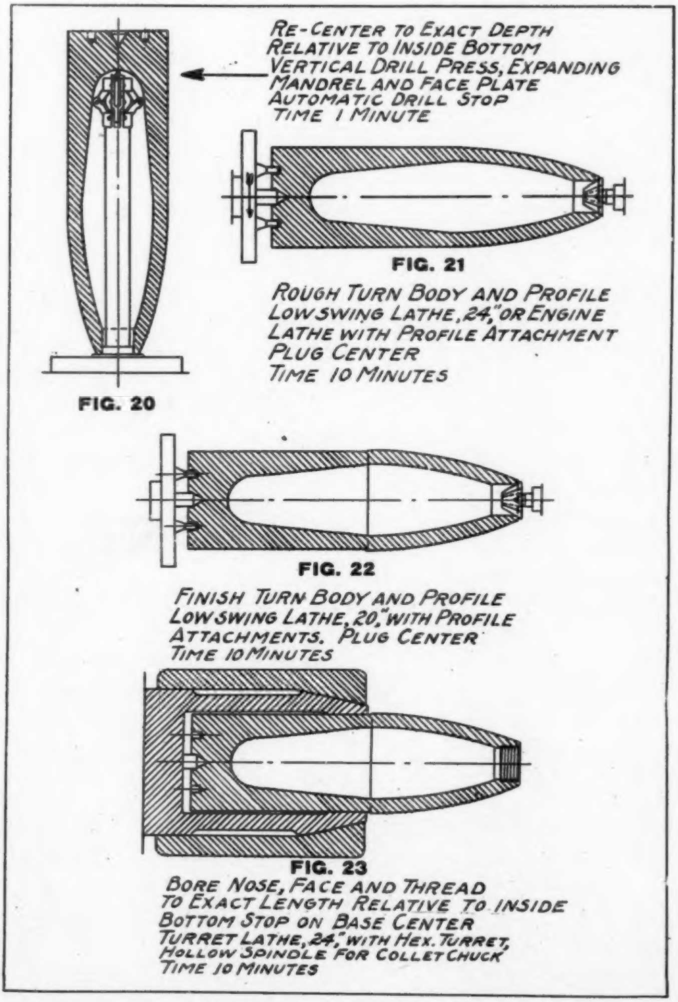


FIG. 20—DRILLING THE CENTER IN BASE TO EXACT DEPTH. FIG. 21—ROUGH TURNING FROM NOSE TO BASE. FIG. 22—FINISH TURNING OF BODY AND PROFILE. FIG. 23—FACING, BORING AND TURNING THE NOSE

as the butt of the shell and usually a height equivalent to the diameter.

The dry-sand core is made on a steel arbor, which fits accurately into a hole or socket in the bottom of the flask, the core being clamped securely by means of a nut on the end of the arbor. A split corebox is used, the core being rammed endwise. Other methods of making the core also may be employed and will be described in detail later.

The metal must be carefully melted and poured as hot as possible. From 20 to 30 per cent of steel scrap is employed in the mixture. Detailed analyses will be presented further on. In general, the total carbon plus silicon for castings 155 millimeters and larger should equal approximately 4.40 per cent; for 75-millimeter shell the total carbon plus silicon should equal 4.70 per cent. The castings should be cooled slowly in the sand and not shaken out until they are black. An air hoist of the vertical cylinder type is usually employed for shaking out the molds.

The shell may be cleaned effectively on the outside by tumbling. The inside may be cleaned by sand-blasting, although it probably will be found more satisfactory to employ the wire-rope type of cleaning machine which will be described later.

A testing frame, in which the shell may be quickly and tightly clamped together with a high-pressure pump and accumulator is necessary for making the specified hydraulic test. As previously stated, the impact test is made on a special machine and the tensile test on a standard machine. The test bars are cast vertically in dry-sand molds. Bottom pour gates are usually employed and the molds are filled to overflowing in order to produce a sound bar. An overflow gate at the top of the mold is provided for this purpose. The test bars must be allowed to cool to a black heat in the mold as provided in the specifications.

How the Cores Are Made

A study of the situation has revealed that several methods may be employed for making the cores successfully. The core is an exceedingly important part of the job and it must

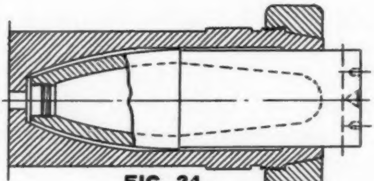


FIG. 24

CUT OFF BASE
CUT OFF MACHINE, COLLET CHUCK,
DOUBLE TOOL POST
TIME 5 MINUTES

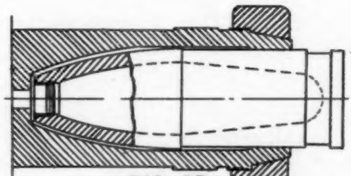


FIG. 25

BAND GROOVE AND UNDERCUT
COLLET CHUCK WITH NOSE STOP
TIME 4 MINUTES
NOTE:- IF LOW SWING LATHE IS USED ON
19 AND 20 THIS OPERATION CAN BE DONE
SIMULTANEOUSLY

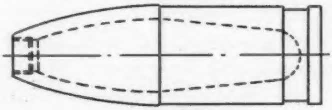


FIG. 26

WEIGH AND MARK
AUTOMATIC SCALE AND
SPECIAL MARKING GAUGE
TIME 1 MINUTE

FIG. 24—CUTTING OFF THE BASE. FIG. 25—TURNING AND UNDERCUTTING THE BAND.
FIG. 26—WEIGHING AND MARKING

do the work for which it is intended in a flawless manner. It must produce a shell which is free from imperfections on the inside, as specifically provided in the specifications; in addition, the core must be centered with extreme accuracy in order that the shell may be concentrically balanced.

The method of making the cores which has behind it the greatest weight of experience at the present time is illustrated by the accompanying photograph and drawings submitted by the American Radiator Co. As these illustrations show, the cores are made in accurately machined cast-iron boxes and are dried at a definite temperature while suspended on their arbors in racks of special construction. After drying they are dipped in blacking and redried before being delivered to the molding floor.

The details and dimensions of the core boxes for the various sizes of shells are shown on the detailed drawings. It will be noted that they are made as light as possible and are properly ribbed to insure stiffness. The boxes are in two parts, split parallel to the axis of the core. A simple clamping device is provided for holding the two parts of the box together while the core is being rammed up. The arbor passes through a machined hole, similar to that provided in the flask, and is clamped rigidly in place by a thumb nut. The core is rammed from one end by hand, using a very light wooden ramming stick, the rounded upper or rear end being formed by a detachable nosepiece which is fitted on the top of the box as one of the final operations in making the core. The box is provided with trunnions on which it may be swung into a convenient position for ramming and unclamping. The trunnions are supported by a wooden frame of special construction shown in one of the accompanying illustrations.

The arbors are made of extra strong wrought-iron pipe, ½-inch pipe being employed for the 4.7-inch and 155-millimeter shell. For the latter the arbor has an overall length of 27 inches. The ferrule or seat portion which fits into the flask is 5¾ inches in length for 155-millimeter shell. The clamping nut works against a ½-inch collar, which is forced on the arbor as shown on the attached drawings. To pro-

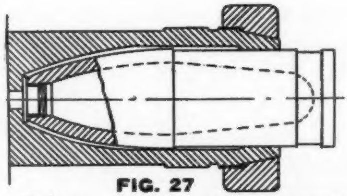


FIG. 27

FINISH BASE AND CHAMFER
FACING MACHINE
TIME 4 MINUTES
NOTE:- GROOVE BASE FOR HIGH
EXPLOSIVE SHELL

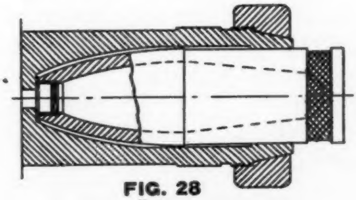


FIG. 28

KNURL BAND GROOVE
KNURLING MACHINE
TIME 2 MINUTES

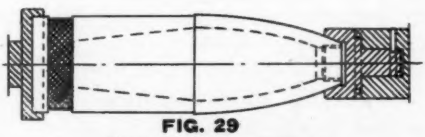


FIG. 29

GRIND BOURLETTE
PLAIN CYLINDRICAL GRINDER
SPECIAL HEAD AND TAIL STOCK
FIXTURE OPERATED BY FOOT LEVER
TIME 2 MINUTES
NOTE:-AIR TEST

FIG. 27—FINISHING THE BASE AND CHAMFER. FIG. 28—KNURLING THE BAND GROOVE. FIG. 29—GRINDING THE BOURRELET

vide for the escape of the gases when pouring the mold the arbor is drilled with 3/16-inch holes throughout its length.

To provide a surface to which the sand may cling more satisfactorily the arbors are wrapped with strips of burlap about three inches wide. The sand in the 155-millimeter core weighs 13 pounds and the arbor 16.5 pounds, the total weight being 29.5 pounds.

The Core and Mixture

The core should be carefully compounded and preferably prepared in a paddle-type mixer to insure a uniform product. The following sand mixture has been found satisfactory: Eight shovelfuls of old molding sand; 3½ shovelfuls of lake sand or silica sand sifted through a No. 4 riddle; four shovelfuls of green-molding sand; and one shovelful of sawdust, to which is added 1½ pints of molasses. For the largest and smallest sizes of shell some slight modifications in this mixture may be advisable.

In ramming up a core twelve operations are involved, as follows:

Operation

1.—Oil interior of box.
2.—Set arbor, previously wrapped with burlap in half of box.
3.—Close and clamp box.
4.—Fill box with sand.
5.—Ram lower part of core around arbor with curved ramming stick.
6.—Place small wooden hopper to hold surplus sand on top of corebox and finish ramming.
7.—Place three nails in top of core.
8.—Set nosepiece on top of box.
9.—Ram nosepiece full of sand using a large nail.
10.—Take off nosepiece, thus forming rounded end of core.
11.—Unclamp corebox.
12.—Swing box and take out core.

As previously mentioned the cores are suspended on their arbors from a rack for drying. A car-type oven is em-

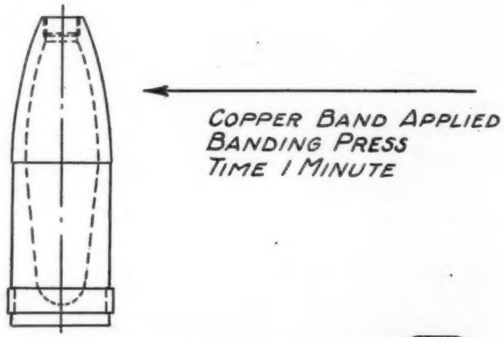


FIG. 30

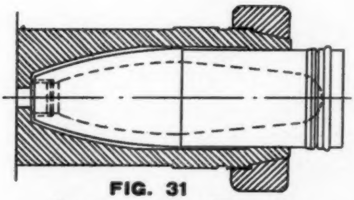


FIG. 31

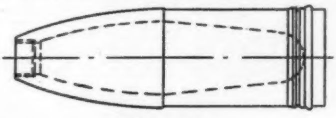


FIG. 32

FIG. 30—APPLYING THE COPPER BAND. FIG. 31—TURNING THE COPPER BAND. FIG. 32—PAINTING THE SHELL

ployed and the rack that carries the green cores forms a part of the car. This arrangement is clearly shown in the accompanying illustrations. The cores are dried in batches of about 100. The cores may also be dried by setting the arbors in sockets provided on the car, thus supporting the cores in an upright position. This form of drying arrangement is mentioned under Fig. 8. The hanging method, however, is preferred.

The cores for 155-millimeter shell are baked about 3½ hours at from 400 to 450 degrees Fahr. The cores for 75-millimeter shell need not be baked more than an hour. After baking the cores are dipped in a special blacking in order to give them a proper finishing. This blacking is made as follows:

Mix three parts of mineral facing with one part of finely ground graphite and dilute with water and fine Jersey clay to a creamy consistency, using only enough clay to give the necessary bond. After the clay is added the blacking should be tested to be sure it is sufficiently viscous. In other words it should stick properly to the sides of the core. To test it, moisten the finger in the blacking and blow on the finger nail; a film of small black grains should adhere; if there is too much clay a large number of white grains will appear mixed with the black. When the core is dry the blacking should not stick to the hands. If it does it probably does not contain enough clay.

The cores are blacked by dipping, this operation being performed after the termination of the drying period. After dipping, the blackened cores are again placed in the oven and redried for about 45 minutes. When they come out of the oven a second time the cores are ready to be delivered to the molding floor. For this purpose the transfer rack shown in one of the accompanying illustrations is provided.

While the foregoing method of making the cores is perhaps not as rapid as others which might be employed, it is believed that it is preferable for the average foundryman on account of the fact that if it is followed conscientiously satisfactory results are assured, and since so much depends on the core a little extra effort is well repaid in the resulting

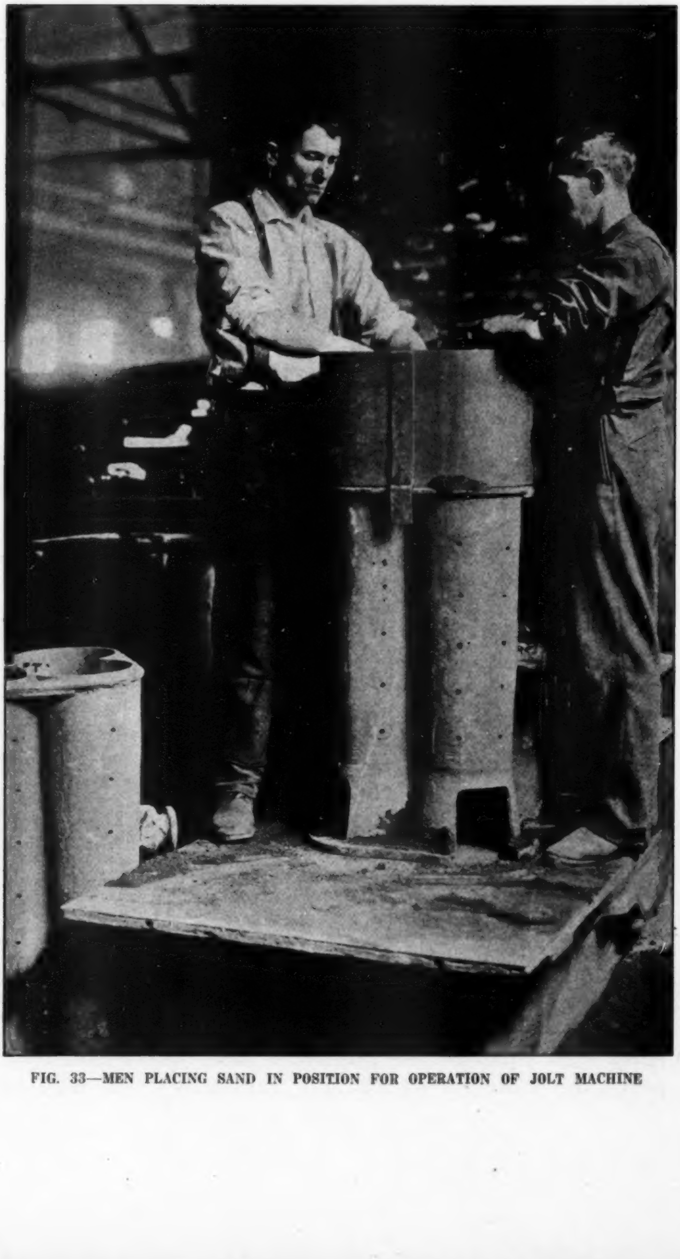


FIG. 33—MEN PLACING SAND IN POSITION FOR OPERATION OF JOLT MACHINE

reduction in number of rejected shells. It is believed that cores can be made according to the method just described at the rate of ten to twelve per hour, per worker, or per core box, and there is no reason why women cannot be employed for this operation.

Alternative Methods of Coremaking

As an alternative method of making the cores, a plain oil-sand mixture with a ratio of approximately 1 to 60 or 70 may be employed and the cores blown by compressed air in a machine of the Demmler type. Uniform cores can be obtained by this method and one machine should turn out roughly fifty cores per hour. The cores are dried in a perforated dryer, resting on one side. An arbor similar to that previously described is employed, although it is not customary to wrap the arbor with burlap. These cores may be made oversize and ground to accurate contour on a form grinder.

As the semisteel shell program expands, other satisfactory methods of making the cores very likely will be devised and important modifications of the existing recommended methods undoubtedly will be in order. In this connection, it has already been suggested that the cores be made on small jar-ramming machines. This may be feasible, although it is not recommended for foundrymen anxious to get on a tonnage basis as quickly as possible unless they have already had wide experience with intricate oil-sand jar-rammed cores. Such experiments as have already been conducted along this line on cores for semisteel shell seem to indicate that owing to the bottle-like shape of the core, it is difficult to ram it properly and to prevent it from being soft at the top. Also it shows a tendency to split when jar-rammed due to the whip of the arbor.

Molding Operations

As previously suggested the molds may be made either in quadruple flasks in which there are four castings, or in single flasks, according to shop conditions. If the shop is fairly well equipped the quadruple flask will undoubtedly prove the most economical and satisfactory for shell of

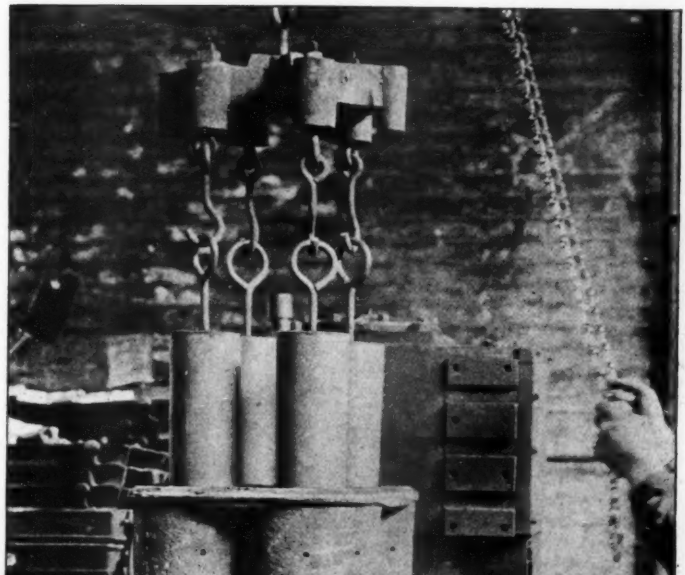


FIG. 34—DRAWING FOUR PATTERNS FROM THE SAND AT ONE TIME

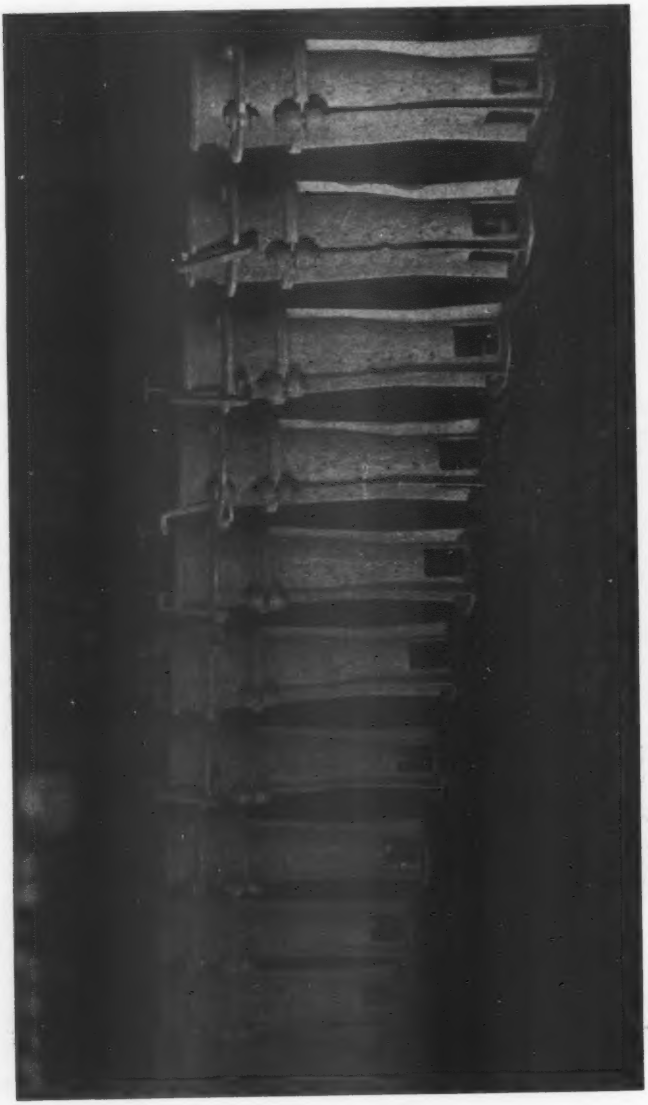


FIG. 35—SINGLE-FLASK MOLDS READY FOR POURING

FIG. 36—CLEANING INSIDE OF SHELL BY MEANS OF FLEXIBLE RAPIDLY-REVOLVING STRANDED WIRE CABLE

medium size. The 75-millimeter shell can be molded six or eight in a flask, while single flasks appear preferable for sizes larger than 8-inch. The flasks are made of gray iron.

The construction of the flasks is clearly shown in the accompanying illustrations, Figs. 33, 34 and 35. It will be noted that they are heavy and rigid, built for rough handling. For jarring-machine use the lower flanges are machine finished to an even bearing. The holes through which the core arbors pass also are accurately finished. In cross section, the quadruple flask is shaped like a four-leafed clover, each shell mold fitting in its individual pocket which contains just the requisite quantity of sand. This flask is designed to use the minimum possible quantity of sand, and to this end a projection extends up through the middle where otherwise there would be dead sand.

The patterns are gray iron, turned and finished to conform to the contour of the shell. An arbor of the same diameter as the core arbor is fitted into the nose or ogive end of the pattern. When the pattern is set in the flask this arbor extends through the hole provided in the flask for the core arbor. It also is threaded similarly to the core arbor, thus making it possible to clamp the pattern firmly into position by means of large thumb nuts. The upper end of the pattern is fitted with a ring for the purpose of drawing it from the sand. By means of a yoke suspended from a cylinder-type air hoist, the four patterns in the quadruple flask may easily be drawn at one time. The use of combination jar-ramming and pattern-drawing molding machines has been suggested but it is doubtful if any of the standard machines have sufficient length of draft. The flask is not rolled over. The pattern is made with considerable draft and therefore it comes out of the sand easily. The slight reverse taper on the butt end of the shell is obtained in the machine shop.

The molding sand presents no special features. It is not necessary to provide a special facing sand. The sand should be as coarse and as weakly bonded as possible in order to provide for the free escape of the gases. For 4.7-inch and

155-millimeter shell No. 4 or No. 5 sand will be found satisfactory.

For turning out shells up to 155-millimeter a jarring machine with a 24-inch table is required, if the quadruple flask is employed. The machine, of course, should have a lifting capacity in excess of 1400 pounds, which is the approximate weight of the flask, sand and pattern.

For 8-inch shell a machine with 28-inch table and a capacity of approximately 1700 pounds should be provided. A traveling direct-acting air-hoist of the vertical cylinder type with a nominal capacity of one ton forms a satisfactory device for handling the flasks on and off the machine and from the machine to the floor. Of course, other equipment, including jib cranes and light traveling cranes may be used, depending upon the existing equipment in the shop.

Method of Making the Mold

A satisfactory method of making the mold, using the quadruple flask is clearly shown in the accompanying photographs. A plain jar-ramming machine of ample capacity is recommended. To get the maximum production, duplicate pattern equipment should be provided. This eliminates the delay which otherwise occurs while the patterns are being fitted in the flask, since the duplicate equipment makes it possible to fit up one flask while its mate is being rammed up on the machine.

On each floor two men will be required to operate the machine together with two others to ram-up the pouring basins, set the cores and close the molds. In addition, if the continuous pouring process is employed two more men will be necessary to pour and shake out the molds. Where considerable floor space is available and large melting capacity at hand, the molds may, of course, all be poured at one time at the end of the day in the conventional manner. At all events separate shake-out and clean-up gangs probably will be found advisable. Each floor or unit, including one jar-ramming machine should turn out 100 molds per day, ten hours, thus giving an output of four hundred shells per floor per shift. Unless the continuous pouring process is

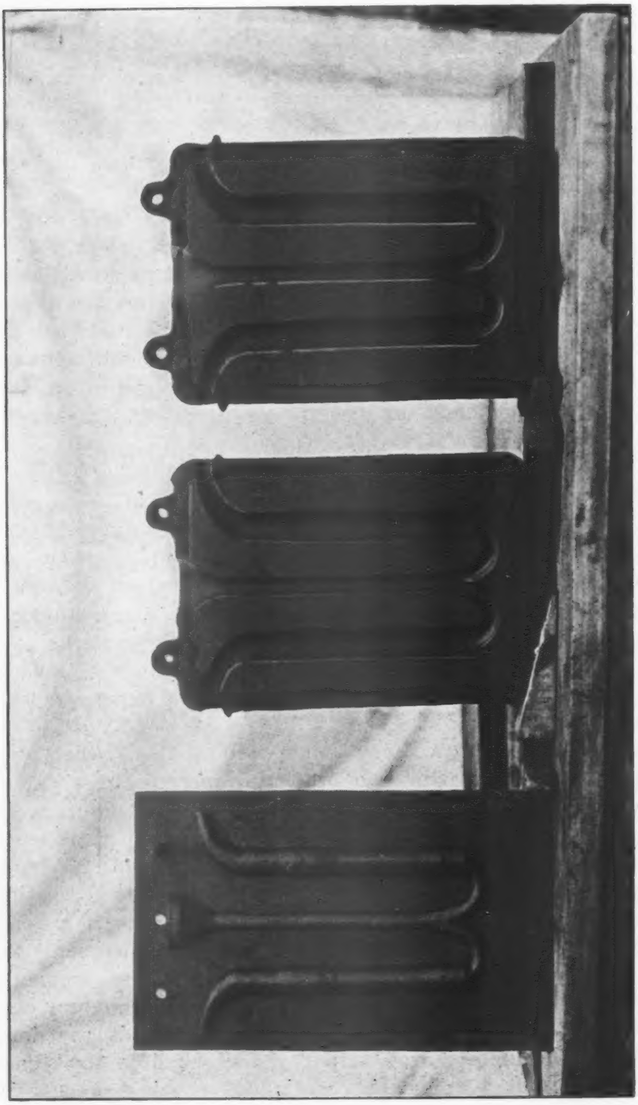


FIG. 37—TWO HALVES OF MOLD FOR ROUND (TENSILE STRENGTH) TEST BAR AND PATTERN FOR SAME

used, 100 or more flasks per floor will, of course, be necessary.

The details of the pouring basin which is set on top of each flask and takes the place of the cope, are shown clearly in the accompanying photographs. This part of the job consists essentially of a dry-sand core surrounded by a metal jacket in which enough green sand is rammed to form a basin. The jacket is provided with guide pins in order to accurately center the basin over the four molds in the quadruple flask. The pouring basin is provided with four drop grates, one for each shell, of the type frequently employed in casting automobile cylinders. This gate consists simply of small holes about ¼-inch in diameter arranged in the dry sand floor of the pouring basin in the form of a circle slightly less in diameter than the shell, there being one such circular strainer for each casting. In addition, a dry-sand vent about ½-inch in diameter extends above the surface of the molten iron in the basin, over the center of each mold, in order to provide suitable exit for the gases coming off the main core. The pouring basin is made by hand on a bench, the dry-sand core which forms its principal element having been previously made in the same manner using the pattern shown in one of the accompanying illustrations.

There are approximately 17 operations involved in making each mold. These operations may be tabulated as follows:

Operation

No.

1.—Turn flask over by means of air hoist.

2.—Set and clamp four patterns by means of thumb nuts.

3.—Blow or brush surplus sand off molding machine table.

4.—Set sheet-iron hopper on top of flask to carry surplus sand.

5.—Two men shovel sand into flask, flask being on floor,

6.—Hoist flask to table of jar-ramming machine.

7.—Clamp flask to machine.

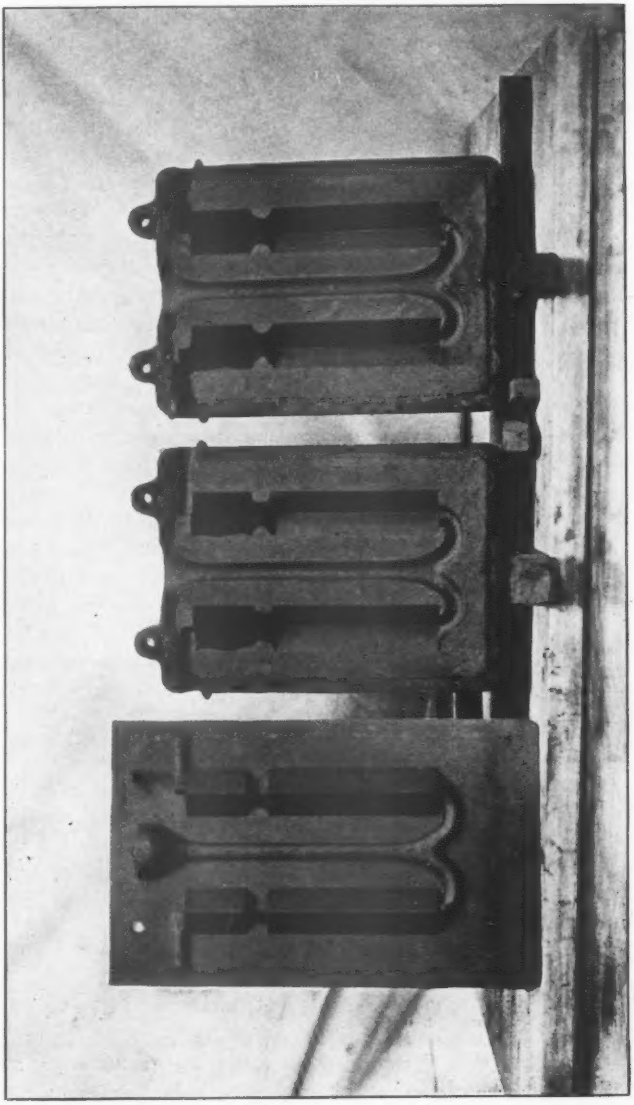


FIG. 38—TWO HALVES OF MOLD FOR SQUARE (SHOCK TEST) BAR AND PATTERN FOR SAME

8.—Bump mold 70 to 90 times.
9.—Take off hopper carrying surplus sand.
10.—Butt peen top of mold with hand-rammer.
11.—Strike off sand and swab around patterns.
12.—Unclamp flask and patterns.
13.—Draw out four patterns at one time, using yoke, immediately resetting patterns in empty flask.
14.—Transfer flask to floor.
15.—Black interior of mold with plumbago, using brush and fingers—blow out excess dust.
16.—Set and bolt cores firmly in place.
17.—Set pouring basin on top of mold and clamp in position.

The operations involved in preparing the pouring basins are as follows:

OPERATIONS

No.
1.—Set jacket on bench and insert core and pattern.
2.—Fill with sand.
3.—Ram with small bench rammer.
4.—Strike off.
5.—Draw pattern, leaving strainer gates and vent cores exposed, thus finishing pouring basin.
6.—Transfer to mold and clamp in place.

If the single flask is used, the sequence of operations is practically the same as just described, except of course that the ramming may be done by hand instead of by machine. If single flasks are used in connection with a jarring machine, one of sufficient size to ram two flasks at one time would be preferable. For shell up to 155-millimeter a machine with a 16 x 30-inch table will fulfill these requirements. If the single flasks are to be jar-rammed one at a time a machine with a 14-inch table would be sufficiently large.

Melting the Metal

The metal for practically all the semisteel shell made in France is melted in cupolas. The preponderance of experience, therefore, leans toward this method of melting. Air furnaces, such as those used in malleable iron foundries

in the United States, also may be employed and this type of furnace has a certain advantage, including the ability to refine the bath to a certain extent. It seems reasonable that this type of furnace should be specially adapted to the use of high phosphorus raw material, including southern pig iron, and experiments to determine the possibilities of the air furnace along this line are now being made under the auspices of the Semisteel Shell Committee on Manufacturing Practice. Since these experiments are as yet incomplete, this report will confine itself to cupola melting.

It is not our purpose to go into a lengthy exposition of the metallurgy of semisteel. It is assumed that foundrymen who undertake shell contracts are already well informed along these lines and are aware of the necessity of melting scientifically under strict laboratory control. In this connection the following quotations from the French report on the manufacture of semisteel shell are especially illuminating:

"Some well known foundries thought they could handle semisteel as they had always handled ordinary cast iron, by rule-of-thumb. They encountered troubles which they deserved, having been compelled either to abandon the manufacture of semisteel shell or to adopt like their colleagues, methods based on chemical analysis."

It is essential that foundries undertaking a semisteel shell contract be provided with laboratories, or that they have access to reliable laboratories close at hand where the necessary tests and determinations may be made. The melter in direct charge of the cupola must also have had a sufficient experience to obtain uniform and reliable results.

The raw materials which are now available, including coke, pig iron and steel scrap are frequently of unsatisfactory quality, thus increasing the metallurgical difficulties involved. The coke should have as much fixed carbon and as little sulphur as possible; the phosphorus and sulphur in the pig iron should not exceed certain fixed limitations and preferably the steel scrap should be of a quality containing not over 0.06 per cent phosphorus. The cupola mixtures consist exclusively of pig iron, steel scrap and foundry remelt.

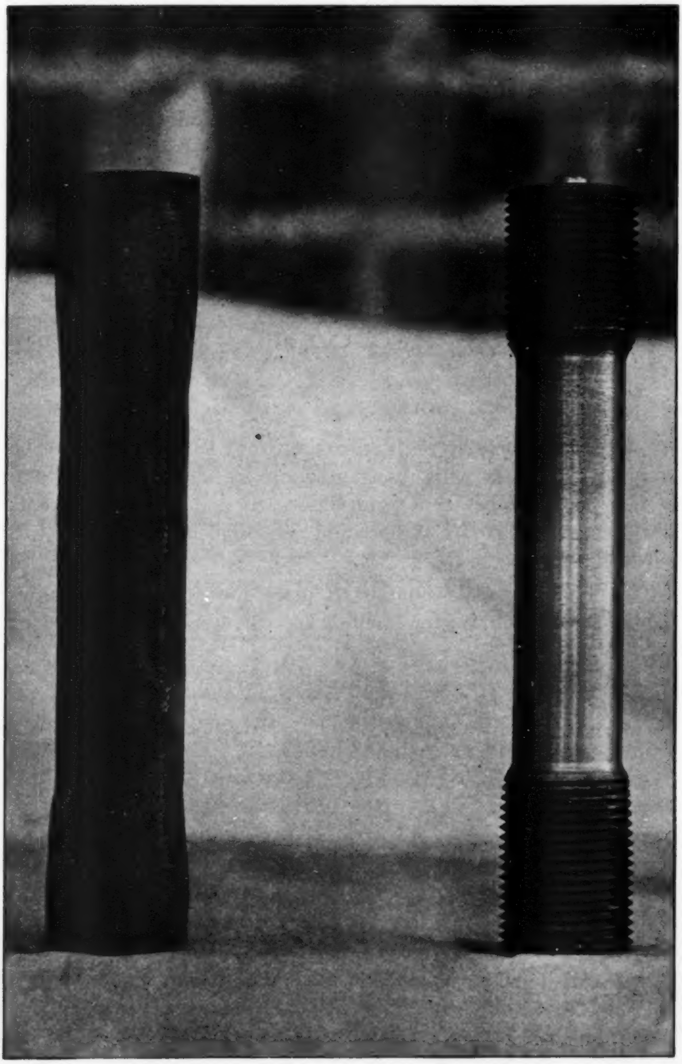


FIG. 39—ROUND OR TENSILE STRENGTH BARS ROUGH AND FINISHED

The analysis of each element in such a charge is definitely and accurately known. Gray iron scrap of uncertain composition cannot be employed.

The foundry must operate within close chemical limits. These limits for shell of 155 millimeters and larger are as follows:

	Per Cent
Silicon	1.10-1.30
Phosphorus up to	0.35
Manganese up to	1.00
Sulphur	0.08-0.12
Total carbon	3.10-3.20
Graphitic carbon	2.40-2.60
Combined carbon	by difference
Silicon + total carbon	4.40

For 75-millimeter shell silicon up to 1.40 per cent may be employed together with manganese up to 0.90 per cent; total carbon 3.20-3.35 per cent; graphitic carbon 2.50-2.70 per cent; the sum of the total carbon and silicon being equal to 4.70 per cent.

A typical cupola charge to meet the foregoing requirements for 155-millimeter shell is as follows:

Analysis

	Pounds	Si.	P.	Mn.	S.	TC	GC
Buffalo Pig No. 3	300	1.82	0.670	0.56			
Wickwire Pig No. 3	330	2.01	0.560	0.82			
Steel (shell Butts)	620	0.10	0.042	0.78			
Remelt	700	1.31	0.290	0.76			
Ferrosilicon	50	12.00	0.070	...			
Ferromanganese	6			80.00			
Calculated analysis		1.39	0.310	0.98			
Analysis by Laboratory		1.19	0.300	0.73	0.117	3.14	2.40
Total	2006						

The foregoing provides for a single charge weighing 2006 pounds. This is designed for a cupola 66 inches in diameter inside of lining. The cupola was being operated at the time on

light heats. If heavy heats were being poured the charges would be doubled or brought up to 4000 pounds each. The coke bed in the cupola in question is brought to 36 inches above the upper tuyeres. To melt the 2006-pound charge detailed above, coke charges of 275 pounds each are employed together with limestone charges of 250 pounds each. A blast pressure of from 14 to 16 ounces is employed. The cupola has a rated capacity of about 18 tons per hour. The coke is of the following composition: Fixed carbon, 89 per cent, sulphur, 0.50-0.69 per cent; volatile matter, 1.45 per cent; ash, 9.41 per cent.

Test bars poured from the foregoing heat show an impact test height of 24 inches. The results of the tensile tests were as follows:

	Pounds per square inch
First ladle of iron	32,690
Second ladle of iron	35,550
Third ladle of iron	36,080

The French experiments on the metallurgy of semisteel resulted in the development of the following general principles:

"It being understood that the amount of carbon is between 2.75 and 3.25 per cent and that all other elements are constant, the strength of the semisteel increases in inverse ratio to the sum of the total carbon and silicon.

"Good semisteel obtained from the cupola should satisfy the following empirical law: Total carbon plus silicon = 4.40 to 4.50 per cent.

"The proportion of silicon should vary in inverse ratio to the caliber of the shell.

"The proportion of manganese should increase in direct ratio to the caliber of the shell.

"The ratio of silicon to manganese should decrease with the caliber of the shell."

Should you be unable to secure a low phosphorus pig iron, the following examples will show you how medium phosphorus in the pig may be reduced in the mixture by the addition of steel scrap, using a percentage of foundry return scrap. The examples follow:

EXAMPLE NO. 1

	Phosphorus per cent
50 per cent pig, phosphorus .....0.55 x 50 per cent =	0.275
30 per cent steel, phosphorus .....0.07 x 30 per cent =	0.021
20 per cent returns, phosphorus ..0.42 x 20 per cent =	0.084
Phosphorus in mixture, per cent................	0.380

EXAMPLE NO. 2

40 per cent pig, phosphorus ......0.55 x 40 per cent =	0.220
30 per cent steel, phosphorus ....0.07 x 30 per cent =	0.021
30 per cent returns, phosphorus...0.34 x 30 per cent =	0.102
Phosphorus in mixture, per cent................	0.343

EXAMPLE NO. 3

30 per cent pig, phosphorus .....0.55 x 30 per cent =	0.165
40 per cent steel, phosphorus ....0.07 x 40 per cent =	0.028
30 per cent returns, phosphorus ..0.27 x 30 per cent =	0.081
Phosphorus in mixture, per cent	0.274

EXAMPLE NO. 4

Presuming that we have a pig iron with 0.90 per cent phosphorus.

30 per cent pig, phosphorus ......0.90 x 30 per cent =	0.270
40 per cent steel, phosphorus.....0.07 x 40 per cent =	0.028
30 per cent returns, phosphorus..0.42 x 30 per cent =	0.126
Phosphorus in mixture, per cent................	0.424

The cupola practice should follow the best accepted American standards for melting semisteel. A hot fluid metal is essential and it is not believed advisable, to economize on coke to such an extent as to interfere with the fluidity of the metal. The charges, of course, must be proportioned to the diameter of the cupola and fairly heavy charges are recommended. If a charging machine is used it should be designed to distribute the charge as evenly as possible over the area of the cupola. It is believed that the best results will be obtained by charging the steel scrap carefully by hand in order to thoroughly distribute it. The French have found that charges ranging from

1/6 to 1/8 of the hourly output of the cupola give satisfactory results. The consumption of coke, according to French experience is about 15 per cent of the weight of semisteel produced.

The ideal steel scrap, of course, consists of crop ends of forged steel shell or shell billets. Next in order comes plate scrap, including clippings and punchings from structural and boiler shops. The shipyards and ship fabricating plants of course, are producing a large tonnage of scrap of this character at the present time. It is believed, however, that a shortage of steel scrap will eventuate and that it will be necessary to resort to the use of material of less satisfactory quality than that now available.

The silicon in the mixtures is controlled by the use of 10 to 12 per cent ferrosilicon and the manganese is also controlled by proper additions of 70 per cent ferromanganese. It is impossible, of course, to reduce the sulphur in the cupola and the carbon also is usually increased due to absorption of carbon from the coke.

The cupolas must be provided with large mixing ladles in which the charges can be tapped and a uniform mixture of iron obtained. For a cupola running from 14 to 16 tons per hour, this ladle should have a capacity of approximately five tons. In general, however, the arrangement of ladles and pouring apparatus will have to depend upon the equipment with which the shop already is provided.

Molding the Test Bars

The test bars are molded by hand in small iron flasks, approximately 10 x 14 inches in size. The details of the molds showing the bottom-pour gate, the risers and the overflow gates for carrying off surplus metal are shown clearly in the accompanying illustrations. The patterns for the test bars are split and mounted on plates to simplify the molding operations. The molds are carefully baked in an oven before the bars are poured. The specifications provide that the molds shall not be opened until the bars reach a black heat. It is essential from the standpoint of safety to the artilleryman that the metal in

the test bars be identical with that in the shell and that as far as possible it be cast under similar conditions.

The principles of the impact testing machine have already been described. This machine is of the pile-driver pattern and consists essentially of a heavy hammer weighing 25 pounds complete, a mechanism for tripping the hammer and gaging its height by increments of ½ inch, knife edges for supporting the test bar, and a pair of hammer guides which permit it to fall freely and accurately. The tripping mechanism is exceedingly simple and effective in operation, and its construction will be readily understood by reference to the drawings. This statement also applies to the other details of the testing machine. The anvil weighs 1763.7 pounds; the government's specifications call for 1750 pounds.

The tensile testing machine as previously mentioned should be of the standard type. This machine, of course, should have sufficient capacity for breaking the bar. A machine rated at 100,000 pounds will be ample. Threaded grips are desirable as previously explained.

Cleaning-Room Practice

Less data are available covering methods of cleaning semi-steel shell than concerning almost any other phase of their production in the foundry. The leading authorities appear to be of the opinion that the shell can be most readily cleaned on the outside by tumbling in mills of suitable size and capacity. The possibilities of the sand-blast for this operation do not appear to have been thoroughly investigated up to the present time.

Before the shells are tumbled or otherwise cleaned it is necessary to saw off the riser and the nose. This is most advantageously accomplished in a cold sawing machine of standard construction, as shown in one of the accompanying illustrations. It is stated that 6½ minutes are required to saw off the riser and nose of a 4.7-inch shell.

The shell is cleaned inside either by sand-blasting or by means of a stiff wire cable mounted vertically in a rapidly revolving spindle. The strands of the cable are separated so that as it is rapidly whirled around in the shell, it acts as a wire brush and completely and quickly removes the adhering

core sand. For this operation the shell is suspended in the air, nose down, from a pair of tongs carried in a chain hoist. The details of this form of cleaning machine together with the accompanying tackle for handling the shell are clearly shown in one of the illustrations presented with this report. It is sometimes necessary to further clean the inside of the shell with a chisel bar to remove small projecting pieces of metal, although the foundrymen should aim to make castings from which the core will come out smoothly, thus avoiding this operation.

After the shell are cut off and cleaned, they are ready to go to the machine shop, it being assumed that the test bars have satisfactorily met the requirements of the government.

French Semisteel Shell Manufacturing Practice

By Lieutenant Colonel Martinon, French Army

Upon the advice of General Hormant experiments on semisteel shell were made before the war at the French arsenal of Douai. This manufacture, supervised and placed on a practical basis by Major Prache, has been applied to all orders for cast iron shell of the navy type, to a series of special models and even to parts of machines such as hammer housings, steam boxes, tooling parts, etc.

Semisteel can be produced either in an electric furnace using turnings, or in a cupola, part of the charge being made of briquetted turnings.

Semisteel in War Production of Projectiles

During the first few months of the war, the consumption in ammunition had reached unexpected figures. The sources of production of high explosive steel shell which, before the war, were already small, had fallen to almost nothing. We lacked steel, as our main steel works, representing approximately 80 per cent of the steel production in France, and also our most important forging plants were situated in invaded territory.

It then became essential to resort to cast iron shell. But with ordinary cast iron shell it was necessary, in order to have them withstand the firing stresses, to make relatively thick walls and consequently to decrease the amount of explosive contained in the shell. Besides, when a cast iron shell bursts it yields only a relatively small percentage of effective fragments, that is, of fragments weighing more than 2 grams.

When steel was added to cast iron to obtain semisteel then the strength of the metal increased and consequently: (1) The strength of the body on impact was increased; (2) The quan-

tity of explosive contained was increased as a consequence of the decrease in the thickness of the walls; (3) The fragmentation on bursting was increased and the number of effective fragments came nearer to the number obtained with steel shell.

Besides, the production of semisteel shell presented the following advantages over the manufacture of steel shell:

(a) It is more simple in every way;

(b) Any well managed foundry can be used for the purpose;

(c) The erection of a plant for semisteel shell is much more rapid and less expensive than the erection of a plant for steel shell;

(d) The use of existing foundries spread over the whole country made the labor problem more simple;

(e) The output of a plant for semisteel shell can be increased very rapidly;

(f) The materials which are used in manufacture are less expensive and they can be easily procured. Scrap from the manufacture of steel or cast iron shell is utilized and also the rejected semisteel shell;

(g) The cost is less;

(h) The consumption of coal for a ton of manufactured semisteel shell is notably lower than for a ton of steel shell.

Characteristics of Semisteel—Physical Requirements

The physical requirements of a good semisteel are as follows:

Tension: Tensile strength—above 25 kilograms per square millimeter (35,550 pounds per square inch). Cylindrical test bars 16 millimeters in diameter.

The elastic limit is difficult to determine and seems, in general, to be somewhat lower than 10 kilograms per square millimeter.

Compression: Elastic limit—above 50 kilograms per square millimeter (71,100 pounds per square inch). Cylindrical test bars 16 millimeters or 0.63 inch in diameter.

Crushing strength: Above 100 kilograms per square millimeter (142,200 pounds per square inch).

Transverse strength: Rupture—above 1000 kilograms.

The test bar is a square bar 65 x 10 x 10 millimeters (2.56 x 0.39 x 0.39 inch) and is loaded in its center on supports 30 millimeters (1.18 inches) apart.

The radii of the bearing faces of the supports and of the load are equal to 2 millimeters (0.078).

Hardness: Brinell test (10 millimeters—3000 kilograms—30 seconds) or (0.39 inch—6615 pounds—30 seconds) Br (Brinell hardness number) 200. Diameter of imprint 4 millimeters 25 (0.167 inch) approximately.

All the characteristics, as above described, must be understood to apply to test bars cut from the part of the casting which is submitted to the quickest cooling; this part is, in general, the thinnest part of a casting.

Drop and tensile tests on separately cast test bars, as provided in the specifications of the French war department, give only general information as to the quality of the metal obtained but they cannot give precise information with reference to the individual strength of the castings made out of the same metal.

However, the French ordnance department has been led to adopt this means of control as it allows supervising the production of large outputs of metal, by means of tests which are quick, inexpensive and require but little apparatus. But a manufacturer will be really aware of the qualities of his product only if he undertakes himself to make tests on bars out of the castings themselves.

If the test bars are not cut out of the thinnest part of a casting, then the above defined characteristics will be somewhat lower, and the difference can reach approximately as much as 20 per cent below the above figures according to the thickness of the sections out of which the test bars have been cut.

Chemical Characteristics of Semisteel for Shell

Semisteel as produced directly in a cupola contains from 2.75 to 3.25 per cent of total carbon. The proportion of combined carbon must be as high as possible provided however that it is such that the metal can be easily machined.

For shell even for those of small caliber the proportion of combined carbon must always be well over 20 per cent of the total carbon.

To obtain the desired content of combined carbon the easiest way is to use silicon, as this element acts very positively on the carbon and tends to set free graphite. Consequently for a given content of total carbon and for a given rapidity of cooling the lower in silicon is the mixture then the lower is the content of graphite and consequently the higher the content of combined carbon.

Under the usual conditions the content of silicon necessary to obtain the physical characteristics as defined above will vary between 0.85 to 0.90 per cent and 1.60 to 1.75 per cent according to the content of total carbon of the charge and according to the thickness of the piece as this thickness determines the rapidity of cooling. The rapidity of cooling acts in a contrary manner to the contents of silicon; a rapid cooling prevents the precipitation of carbon as graphite and maintains it in the combined state.

Besides, it is possible to determine exactly the content of silicon maximum and minimum which are suitable for obtaining a given product.

Let us take for instance, the production of projectiles.

By experiments the content of silicon will be determined in order to give a slight hardening of the ogive and of the nose. This will be the minimum content of silicon below which we should experience difficulty in machining the shell. Besides, the formula—total carbon + silicon under 4.50—allows the determination of silicon for an average value of the total carbon of the cast iron used. This formula will give the maximum content of silicon. If the percentage is exceeded, the physical characteristics of the metal are lowered by reason of too large a percentage of graphite in the semisteel.

If, for instance, total carbon = 2.75, then silicon is less than 4.50 — 2.75 = 1.75: 1.75 per cent will be the maximum content of silicon which must not be exceeded otherwise the content of graphite will be too great and the strength of the metal too low.

If on the contrary total carbon = 3.25, then silicon is less than 4.50 — 3.25 = 1.25: 1.25 per cent will be the maximum content of silicon which must not be exceeded.

All the above figures refer to the cast product. But for the calculation of the charge it is necessary to take into account an approximate loss in melting of 0.10 in silicon with an increase in carbon of the same figure if the melting operation is conducted rapidly.

Manganese—Phosphorus—Sulphur

For the regulation of the content of combined carbon, it would be possible either to make the rapidity of cooling vary or to act on the content of manganese, as the action of this latter element is the reverse of the action of silicon. But this method of control would be needlessly intricate.

In general the content of manganese varies within narrow limits in cast irons from the same source. Consequently it is advisable to accommodate oneself to those contents and then to determine, as explained above, the suitable content of silicon in relation to the carbon. With castings containing more than 1.20 per cent in manganese, machining is generally hard on the tools and such castings do not present any advantage in superior strength to compensate for difficulties in machining. An average content between 0.6 and 0.9 is to be recommended.

Phosphorus is detrimental to the strength of the metal. However, a content up to 0.15 or even 0.30 can be tolerated without inconvenience. Experiments made in France with a content of phosphorus superior to 0.30 are not numerous enough to draw any conclusion on this point. The American ordnance department states that, in the United States and in England, good results have been obtained with castings containing much higher percentages of phosphorus than have been used in France. It is also stated by the ordnance department that shells have been produced in England with semisteel containing phosphorus up to 1.00 per cent.

Sulphur seems to have no harmful effect on the strength of the metal in itself. It maintains carbon in the semisteel

and prevents it from separating in the shape of graphite. But, on the other hand, it makes the metal less fluid and decidedly increases the amount of piping and blowholes. Consequently, it should be eliminated as much as possible. However, satisfactory, strong and sound castings can be obtained with a maximum content of sulphur of 0.12 to 0.15.

Independently of any operation relative to machining it seems that the best physical requirements are obtained when the metal contains the same quantity of combined carbon and of graphite (combined carbon = 0.50 total carbon).

Aluminum, as silicon, but in a very much more marked way, has the effect of accelerating the precipitation of graphite. Consequently when aluminum is placed in the casting ladle in order to purify the metal, it is important that the proportion of aluminum be exactly determined, otherwise the quality of the semisteel might be entirely altered. It is absolutely necessary that the total quantity of aluminum used be employed for the deoxidation of the charge and must be entirely eliminated in the slag ($\frac{1}{10.000}$ in weight is sufficient).

Lowering the carbon by dilution with steel is all the more effective when the melting is pushed rapidly, since the melted products remain a shorter time in the cupola.

It is very advantageous to cast very hot, as the metal is more homogeneous, and the liquified products which are present during a slow solidification and which decrease cohesion have no time to be produced. However, owing to the presence of silicon in sufficient quantity the metal remains graphitic and machining is easy.

On the contrary, if for a semisteel of normal chemical characteristics, the cooling is too slow, then the product obtained does not present the strength which would otherwise correspond to its composition, for the separation of too much graphite has taken place and the semisteel becomes gray and of only medium quality.

Some founders had thought that they could make semisteel by purely empirical processes. But they had so much trouble that they had to resort to chemical analysis.

When no laboratory analysis is made it is admitted that for every kind of casting the charge must be composed of fixed proportions of cast irons classified according to their origin and to the appearance of the fracture.

This way of operating presents the following inconveniences:

(a) The foundry is dependent upon determined sources of production of cast iron; if these sources are lacking, then the entire process of semisteel manufacture is thrown into confusion.

(b) The proportion to be adopted of a cast iron of determined origin is absolutely variable. It depends not only upon the ore but also on the process of manufacture. Even assuming that the ores are always identical, any mistake or any accident in the operation of a blast furnace has its immediate result in the chemical characteristics of the cast iron. It is absolutely impossible to ascertain these variations without making an analysis in the laboratory.

(c) When a series of pieces are found defective on account of the quality of the metal it is more difficult to find the proper remedy for it, if there exists no laboratory for making an investigation. But on the contrary, when the composition of the cast iron to be used is known in a precise manner, then by a laboratory analysis it becomes easy to make up the charges with materials at hand by taking variable proportions of each one of them.

Molding

The various processes for molding in use in France are as follows: (1) Flask molding, ramming by hand, or with pneumatic or mechanical rammer; (2) Sectional molding; (3) Machine molding by the use of the jolting machine.

It seems that the third process presents many advantages as its cost of installation is comparatively small and it increases very considerably the yield of hand labor, so that robust men who can be useful in other ways can be replaced. With this process the sand is pressed uniformly.

With the "sectional molding process," the mold is composed of sections which are dried and then assembled. These various sections are generally made by women. When 155-millimeter shells are to be manufactured, the mold consists of three sections: (a) Section corresponding to the cylindrical part of the shell; (b) Section corresponding to the ogive; (c) Section corresponding to the tronco-conical part of the base, and to the riser.

These sections are made out of molding sand (2/3 of fresh and 1/3 of used sand) and are reinforced with wire coils.

The assembly of the various sections is performed on a table on which the shell patterns are fixed. The various sections are placed above each other around the corresponding patterns and sand is then rammed between the pattern and the sections.

With this process it is possible to divide the effort and consequently to use a great number of women; but the yield obtained with this method is not as high as with the machine molding process.

Drying the Mold and the Cores

Shells have been molded by means of either green sand or dry sand. Both processes have given satisfactory results, but, however, many foundries have obtained a decrease in the number of rejections by replacing the molding with green sand by molding with dry sand. By drying the sand the formation of steam during casting is avoided; furthermore permeability is increased which makes the escape of gas easier.

A simple device for drying the sand consists in leading air and hot gas into rectangular conduits placed on the level of the ground where the flasks are resting.

The cores must be dried with the utmost care in order to avoid surface defects and blowholes. In order to ascertain that the cores are perfectly dry it is necessary to select from time to time at random a core to determine its loss of weight by a quick heating. The cores should be dried to constant weight.

Any process for casting can be used. In some foundries the shell are cast with the ogive down, in some others with the ogive up. It seems that the best results have been obtained by casting from the bottom with the ogive down. With this process the portion which contains less metal is at the lower point and there is no danger of a defect occurring in the ogives as the least pure metal containing segregations rises to the surface. But on the other hand with this process blowholes may occur at the base of the shell. Consequently it is necessary to leave a sinkhead of sufficient size to make sure that when the shell is cut to length not only the piping but also every blowhole and metal of bad quality will be eliminated. Furthermore the core must be made with special care and the core barrel must be built with a sufficient diameter and at a proper place so that the gas can easily escape.

In order to ascertain rapidly the quality of the semisteel before and after the casting, use is made of a very simple device which consists in casting a test bar having a trapezoid section. As soon as this bar is cold, it is broken crosswise and the section presents all the varieties of semisteel from the white cast iron to the gray cast iron grading off from the smaller to the larger bases of the trapezium. The height of the white cast iron is then measured and from experience gives quickly indications relative to the quality of the semisteel in the cupola.

Use of Semisteel After the War

It is certain that after the war semisteel will be used for building a great number of parts of machinery which have to bear comparatively high stresses.

It seems that for the present time it is rather difficult to obtain practically, for large outputs strengths over 33 to 35 kilograms per square millimeter with the cupola process only and with the cast iron now found on the market. But, on the contrary, the above mentioned figures can be materially increased if use is made of cupola products on one hand, and products obtained in a converter or in an open-hearth furnace on the other hand, with subsequent heat treatment of the castings. But production then loses the character of out-

put on a large scale and at low cost which accompany the use of the cupola alone.

However, by adding to the semisteel obtained by the cupola process special metals, melted separately, such as nickel or nickel steel, for instance, a complete scale of very interesting special semisteel can be obtained.

By the use of nickel, in particular, a semisteel can be obtained which is very easy to mold, gives a forgeable metal, is very hard and consequently can be usefully used for making equipment for shaping, matricing and stamping. It is certain that the numerous experiments which will be made will provide for semisteel a very wide field of application.

Discussion on Semisteel Shell Manufacture

Capt. H. M. Huxley.—I want to say just a few words regarding the semisteel shell, as a representative of the engineering division of the ordnance department. The manufacture of semisteel shells has been undertaken to a very large extent in France for several years, and also in Great Britain; in France, where the semisteel shells are used both for the high explosive shell and for the gas shell, and in Great Britain where they are used, I think, exclusively for gas shell. The experience that has been gained, particularly in France, we think will be of enormous assistance to us in this country in developing our own program.

Our program contemplates both the use of semisteel shell for gas and high explosive purposes, and I want to say just a word about the necessity of careful manufacture. There is nothing that is very difficult about the manufacture of semisteel shell, and yet it takes care on the part of the manufacturer. For example, if only one shell blows up in the gun, the gun explodes, is broken and is apt to kill the gun crew, with a

very bad effect on the morale of the battery. So the safety in the manufacture of the shell, the careful inspection, is very essential.

The materials which are used in the manufacture of shell are those which can readily be obtained in this country, pig iron, steel scrap, about 30 per cent of steel scrap ordinarily. The engineering division has laid down the designs for the semisteel shell for various calibers from the 75-millimeter shell, that is, approximately a 3-inch shell, up to a 240-millimeter shell, which is about 9½ inches in caliber. The program calls for quite a large number of these shell of the various calibers. With proper supervision, proper checking up by the chemical laboratory, etc., the practical foundryman will readily be able to co-operate with the government in the production of these shell and to thus assist in winning the war.

A MEMBER:—What is the smallest tonnage that the government will consider for a contract?

CAPT. H. M. HUXLEY:—Why, we have various divisions in the ordnance department. I am in the engineering division. That question is really one that would normally come before the production division, which is the division that looks, as its name implies, after the production. But I should say off-hand and roughly and without in any way committing the ordnance department or production division, that that plant would probably have to produce in the neighborhood of a thousand shells a day in order to make it worth while, because the overhead, that is, the chemical laboratory and testing arrangements and all those things, have to be provided just the same for a small production as for a large production. The skilled supervision is a job that really requires eternal vigilance, although there is nothing mysterious about it and nothing complicated, but you have got to watch it carefully.

THE CHAIRMAN, MR. JOHN A. PENTON:—That would be 60 tons any way, of a melt per day.

A MEMBER:—Captain, I believe there is a hydraulic test of these shell?

CAPT. H. M. HUXLEY:—Yes, sir, up to 6 inches; roughly it is 4500 pounds per square inch, and above that, 3000. That is made after machining but before painting.

A MEMBER:—In your opinion would it pay the foundry that has not a tonnage of 60 tons a day to put in the equipment on small production?

CAPT. H. M. HUXLEY:—Why, yes, that would be my off-hand judgment. In order to get anything official, it would have to be taken up with the production division.

A MEMBER:—What I am trying to get at is from the standpoint of cost; that is, would it pay to put in equipment for anything less than 60 tons a day?

CAPT. H. M. HUXLEY:—Off-hand, I do not think it would.

A MEMBER:—Are the chemical specifications laid down?

CAPT. H. M. HUXLEY:—In the official government specifications, the chemical end is not specified; the physical requirements are specified. The government will make recommendations which are to be followed by the manufacturers, at any rate very closely for the present, requiring processes of manufacture, and chemical requirements would be one thing, but the final test is whether the physical requirements are met and whether the shell as fired in the gun meets the necessary requirements. The firing test consists in taking the shell, loading it, measuring the diameter of the shell at various points before firing, firing the shell for recovery, and measuring it after firing to get the increased diameter, that is the swell of the shell.

A MEMBER:—Is there any metallographic test?

CAPT H. M. HUXLEY:—Not prescribed.

A MEMBER:—Does the government receive shells made by any other process than sand molding?

CAPT. H. M. HUXLEY:—That, I do not care to discuss; that is confidential.

A MEMBER:—Has the government made any provision for a permanent mold, or has it been tried out?

CAPT. H. M. HUXLEY:—That I do not care to discuss.

A MEMBER:—In case the government has a testing laboratory at a factory manufacturing shells in large quantities, would it give a contract also to a small factory in the same vicinity with a small output?

CAPT. H. M. HUXLEY:—If it could produce shells economically and somewhere near, so the inspection could be carried out with more or less facility, possibly so.

A MEMBER:—That would give an opportunity for a group of foundries to get together and combine in making the tonnage that would be required.

A MEMBER:—Would a failure on the impact test, provided all others succeeded, cause the rejection of the shell?

CAPT. H. M. HUXLEY:—Yes.

A MEMBER:—Are there any torsion tests?

CAPT. H. M. HUXLEY:—No.

A MEMBER:—Is there any relation between the impact test and the transverse test?

CAPT. H. M. HUXLEY:—It is a torsion test in a way; there is a weight that drops on the bar.

A MEMBER:—Is the resilience figured out in pounds of metal, taking the stress times the deflection divided by twice the weight of the bar? That was in our former practice. If the test bar went below seventy in pounds, the wheel was apt to break on the drop test. Is there any relation established on this test?

CAPT. H. M. HUXLEY:—No, not definitely. I would want to go into that question very carefully, because we will have to figure it out. I could not answer that question off-hand.

A MEMBER:—French practice has not established any?

CAPT. H. M. HUXLEY:—Not so far as I know. I would like to discuss that with you from an engineering point of view.

A MEMBER:—There is in the case of car wheel iron, and it varies with each sized bar.

CAPT. H. M. HUXLEY:—We have one constant-sized bar.

A MEMBER:—I thought you would probably establish a constant between the rise and drop and transverse test as figured by the old formula.

CAPT. H. M. HUXLEY:—Well, we have not done that yet.

A MEMBER:—I do not see why a foundry which is already equipped in a more or less complete way, which has already an analytical department, could not add a department for shellmaking to its already going operations and get along

very well with a much less quantity than a thousand per day. That is a very large amount for a foundry.

CAPT. H. M. HUXLEY:—It is possible: in certain instances that might be done.

A MEMBER:—The overhead would be cut down very considerably.

CAPT H. M. HUXLEY:—Yes, that is very possible.

Activities of the Army Ordnance Department Especially as Applied to Foundry Matters

By C. S. Koch, Washington

You may have noticed that it has not been the policy of the ordnance department to advertise itself, to proclaim publicly what it has done, or is going to do. You probably have heard and read less of it than of many of the other various government agencies. Its policy has been one of extreme modesty, in my opinion, and yet it is the largest business organization that has ever been in existence, and is handling a more diversified product than any other organization, either government or private.

All of us are acquainted with certain large industrial corporations. But when one considers the comparatively small number of products, and the fact that the immense size resulted, not from almost nothing, but from hitching together numerous units, all of which were in more or less successful operation, and composed of men acquainted with their duties, when one considers these facts, I repeat, one wonders how it has been possible to produce in something over one year, an organization infinitely greater in number of employes, and handling an immense number of materials and items.

I can perhaps do best to quote General Jamieson, chief of the production division, and when considering what he says, bear in mind that at the time this country entered the war, the total number of employes in the ordnance department was 273, eighty-nine of whom were commissioned officers.

In speaking to a certain group of manufacturers, he said:

"To give you some idea as to the magnitude of the ordnance problem, I want to say that in the last 18 months, over 20,000 separate contracts have been executed; that today, there stand on the books of the ordnance department, over 11,000

active prime contracts; that there are approximately 70,000 subcontractors."

(Let me stop here to mention that probably in the whole foundry business there are not 200 sub or prime contractors—which indicates the extent and breadth of the ordnance department activities.)

He continued: "There are at least 12,000 principal assemblies in ordnance material; there are over 25,000 separate items entered in ordnance production. There are nearly 6000 officers and approximately 40,000 civilian employes."

Then follows: "I am telling you this story to let you get a little conception of the size of the problem of which you are a part, and for which you gentlemen, as manufacturers, and as civilians and citizens of this country are particularly responsible, and are equally interested with us. There has been perhaps on the part of the manufacturers, from a lack of appreciation of the point of view of the individual who is manufacturing a few or a limited number of articles, a tendency to feel that the frequent changes in design which have occurred in some cases, that delays in the execution of contracts, or in placing of orders, which have occurred in some instances, and the lack of intelligent instruction and direction on the part of the production division, is a thing which can be easily corrected.

"If your particular problem, gentlemen, was the only problem we had, the solution would be easy, but you multiply your problem by 25,000 or 30,000, you multiply your problem by all the possible combinations that I have indicated in the numbers given you of 70,000 subcontracts of 25,000 different articles, of troubles here and troubles there, of priorities, of lack of material, of labor, and to bring all of these components together at the right time, in the right way, so as to make the problem a perfectly satisfactory one, is definitely beyond words to describe."

Such a task, such a problem, demands organization. Policies of a general character had to be laid down and sometimes particular problems seemed to call for deviation from these policies. Frequently, your own particular problem may seem to have called for such deviation, and when your particular wish or desire has not been handled just as you would have wished, you have complained and criticized. But remember, a constant or successive deviation from fixed principles, would have led to chaos, and allow me to state that it is my opinion

that it is fortunate for you and the country that the ordnance department has been strong enough, has been sufficiently confident of its well thought out policy, and of its own ability, not to be stampeded by such criticisms and complaints, but instead, has fought straight ahead, has overcome and is overcoming obstacles, and is now and is going to turn out war materials of suitable quality, in quantities and at a rate beyond hope.

Now, more particularly, as applying to foundry matters:

In considering the placing of contracts in the early days of the war, for such apparatus as required castings, the question arose as to whether the ordnance department should buy the castings from the foundries and furnish to the contractors, or whether the contractor should buy the castings.

It was decided, and without doubt correctly, all matters considered, to have the contractors, as a rule, buy the castings.

However, this method has had one very serious drawback, namely, that many foundrymen have not considered an order from a contractor of the government, with, shall it be said, the same seriousness as he would had the order come directly from the government. There has not been in all cases that close connection and co-operation which should have existed. It should be obvious to anyone who thinks sufficiently far, that this should not have had any effect whatever.

However, some subcontractors have had contentions and disagreements with the prime contractors. Production has been arrested or at least slowed up, and in the hurry and stress of the daily tasks, the fact that the ordnance department has been in urgent need of the material has been lost sight of or has become a secondary matter, and the fact that the ordnance department was really a party, or could be, to the transaction has been entirely out of mind. That this should not be, goes without saying, and it is the hope of the ordnance department that no steps, or change in policy will be required to overcome this difficulty which exists in some cases.

Its general policy is to have the prime contractor buy the castings, and I can assure you from a careful watching of the events for some time past, that it is to the best interests of the foundrymen to have the policy remain as now.

As the ordnance department buys few, if any, castings, most of you have not had any direct relations with the procurement division of army ordnance, and this leaves the three remaining divisions, with which you are more or less directly connected, or at least divisions whose activities affect your work to a great extent. These divisions are: 1. Engineering. 2. Production. 3. Inspection.

A brief outline of these divisions is as follows: The engineering—produces designs and specifications; the production—endeavors to get out the work according to these specifications, and the inspection—sees that the finished product is up to these specifications.

It is obvious that time forbids to relate any of the details as to what has been done, or what is hoped will be done by each of these divisions. However, as to the engineering division, it naturally picked up the matter as it stood at our entrance into the war. Changes, in number too great to record, have been made by this division until at present the attitude of the engineering division toward foundry matters is all that could be asked for, all things considered.

The adaptability of this branch of army ordnance to the existing economic situation is a remarkable instance of bigness on the part of the individuals at its head, and it should be a matter of satisfaction to all to know that the heads of the various sections of this division are of such remarkable ability and breadth of character.

It is not necessary to mention to you the general or blanket changes which have occurred in all kinds of specifications. But you do not realize the immense number of changes in design, and substitution of one material for another, which have been made by this division, and almost all of which were made at the requests of manufacturers.

The writer has been connected with the production division. This has naturally brought him into direct contact with this division on many of these changes, and it can be truly stated that the heads of the engineering division have always been willing to listen to, and acquiesce in, every instance of a reasonable proposition that has been brought to their attention in the proper manner.

Of the production division it cannot be said that its only duty has been to get out product according to the specifications, as given out by the engineering division. In addition, it has been and still is its duty to call to the attention of the engineering division any and all changes in design and specifications which will tend to increase production without reduction in the suitability of the quality. Many foundrymen have realized this point, but the number has been small in comparison to those who have plugged along without a murmur.

It is the duty of the production division to assist the manufacturers in every way possible. (The greatest use to which some concerns put the production division is to endeavor to get the inspection division to pass rejected material.)

This following statement can be made without fear of contradiction. Foundries are not availing themselves of the assistance which the production division can often given them.

The division following the production division is that of inspection, the one in which you are mostly interested. I hesitate to venture too far into discussion of this division as I am not a member of it.

Having made ordnance work before going into the department, perhaps I can say what follows with more or less grace. It can be definitely stated that the grasp of the situation by the various heads in this division is remarkable, whatever difficulty arises is due almost generally to that which exists in every large organization, namely, the extent of the task to get their ideas and policies to, and firmly fixed all through, the organization.

To get experienced men in sufficient numbers is out of the question. To educate them is a big job—involving time, and as before stated, to get all to absorb matters of general policy, is a vastly greater one, and to do all of this in an organization of such size and of so many ramifications is a problem beyond comprehension.

The subject assigned to me was evidently intended to embody more or less what the ordnance department has done. It would have been much more to my liking to have had the subject "What Have the Foundries Done, and are Doing."

Notwithstanding the fact that it is not the subject, this certainly must be said. The foundries as a whole, and as an industry, have done remarkably well.

Certain ordnance people believed in the early days of the war that the industry would break under the immense load of special work. Certain ones, whose knowledge of the industry was extensive and who thought they were thoroughly acquainted with the personnel of the industry, and who realized fully that almost no real government specification work had ever been handled by the foundries, had fears that the ordnance program would be seriously hampered by lack of suitable castings, especially steel. In my opinion, this has not been the case as yet. There have been serious cases of falling down on the part of certain foundries—but the industry as a whole should not be judged by them, and further, it may be said that had these foundries exhibited the right spirit of co-operation they would have had sufficient assistance to have helped them out of their difficulties.

In conclusion, this opportunity should be taken to state, and it appears as possibly I am in a proper position to make the statement by reason of my connections with the foundry industry, that the men in the ordnance department, and any other government agency should receive the very earnest co-operation of the manufacturers.

Many a good business man has stated that he could not, and would not, work in an organization such as the ordnance department, and that the necessary restrictions and limitations of his activities would be too burdensome to endure. Consider that many of those in the work fully realized the difficulties before entering, and that many have continued after once starting—many have sacrificed money, and possible advancement, and it seems no more than just that these men should have at least some degree of encouragement from the manufacturers.

It would not be difficult to tell what the ordnance department believes you should do to get out more production and of a better quality. Better quality is by far the most important of the two, and if nothing more could be brought to you today than the one point of improved quality, I would feel satisfied.

Much could be said on this one phase of the situation and its effect on the army program.

The criticism of quality and quantity does not apply to all by any means. The foundry industry has responded well. It has not been necessary for the war industries board to take charge of any branch of the industry and to allocate orders, as has been done in so many other industries, and it is hoped that this point will not be reached.

Whether or not it does come, is probably in the hands of the foundrymen themselves. However, if each wants to make only the simpler, desirable work, and is not willing to take the specification and less desirable work, such steps may be necessary.

Again, the industry has so far conducted itself so well that not one single instance has come to my attention in which it has been necessary for the government to resort to whatever powers it may have, and as this has not been the case in every industry by any means, it seems as if it speaks remarkably well for the foundry industry.

Modern Methods of Transferring Skill

Illustrated by Military Films

By FRANK B. GILBRETH and L. M. GILBRETH, Providence, R. I.

There is today, as never before, an all important need of increasing productivity. This demand is especially keen along the line of war necessities, in which everyone of you here assembled is vitally interested. Where the labor required to produce the product is unskilled, untrained men may be turned in. Where, however, the product requires skilled labor, the problem is entirely different. Usual attempts at solutions of such problems are, longer hours of work or a more rapid rate of production. Either of these methods, unless closely studied from the fatigue standpoint, too often results in decreased quality of product, in depletion of vitality of workers, or in a large labor turnover. (*See Fatigue Study.)

Such methods affect the time element, and increased volumes of product are put upon the market in a reduced time. If, however, along with this goes the usual expenditures of human energy in producing the product, the result is inevitably the expenditure of strength that should have endured throughout a far longer period, a price that later years or future generations must pay. The remedy lies in so increasing the skill of the workers and the number of skilled workers, that it is possible to meet the demands for increased products without undue expenditure of energy.

The fundamental necessity is an increase in skill. This consists of creating additional skill where little or none exists, of fostering and developing such skill as does exist, and of utilizing expertness not only *directly,* to produce products, but *indirectly,* to produce skill itself. The object of this paper is to present the one best method for transferring skill; to show

how skill actually has been and may be discovered, observed and recorded; to demonstrate how it may be taught; to note its effect upon production; and upon the development of the human element.

Military films serve as significant illustrations in that the necessity for increased skill among our war forces is vital and pressing; in that those to be educated possess a wide range of varying qualifications and differing experiences; in that military activity goes back to prehistoric ages and furnishes a fertile field for comparative investigations. These new methods of transferring skill—derived in the industries—have shown themselves also efficient in military training. Therefore no higher recommendation is needed for their application in any new field that may arise in the industries.

Both the films and the methods which they portray demand your undivided and co-operative attention, not only as illustrating principles and practice applicable in your own or any other field, but also as a report of progress in national efficiency.

The films are the work of no one person, of no one type of mind. They are made by the government to embody the efforts of military, professional and industrial experts. They illustrate not only specific details of and directions for performing an activity but also educational theory and teaching practice.

The world is just beginning to realize that the greatest opportunities for teaching and learning are not confined to the school room and the college, but are a part of every activity of life.

Everyone of you here assembled is a teacher, and is responsible for the education of the group under your control. Problems of education are, therefore, of vital, personal interest to you. During the few years in which one is in the schoolroom one learns principally *how to learn.* The actual, most valuable and most usable education comes after one has entered his life work.

The process of education here to be outlined is known as the New Education, ("The Engineer, the Cripple and the New Education"—a paper presented before the American Society of

Mechanical Engineers Dec., 1917). It differs from older methods in many respects. In the first place, as to the derivations of the methods that are taught. The selection of subjects to be studied and methods of presentation have in the past been assigned to those whose *judgment* was deemed most valuable. The selector of the method had probably made a success in some specific line, either as a teacher or a performer of the activity. He was not chosen because of any knowledge of measurement, or scientific ability in determining comparative values. As a result the method transferred was in many cases not only not the best *possible* and not the best *available,* but not even the best then *existing.* Under the new education the method is determined by actual measurement. All competing methods that show elements of excellency are submitted to the most rigid tests. From the results are formulated methods which are used as standards, and all changes and improvements are made from these standards which embody the results of actual intensive investigation. The most efficient methods having been determined, these are taught according to pedagogical practice, which has also stood the test of actual accurate measurement.

There is, then, in the teaching process no "cut-and-dry", no "guess work". The best available material is presented to the learner by the best available method, and the learning period is preferably conducted under laboratory conditions. This new science of education in no way competes with the art of teaching, since individual variation of teacher and pupil must always remain, and since the art consists of handling both these variables successfully. The new methods of education differ, again, from the old methods in the more complete understanding of the necessity of following psychological laws, and in the utilizing of all the senses possible in receiving and in assimilating the material. The older education taught either through the ear or through the eye, and when giving eye training used most often word rather than pictorial descriptions. The new education appeals to both ear and eye, and preferably to these simultaneously, and, while using word descriptions, relies chiefly upon accurate pictorial representation of the methods to be transferred.

The films here presented embody these principles. The methods depicted were derived from intensive study of recognized and unrecognized experts or champions at the activities. The teaching process embodies the latest findings in educational psychology (see "Psychology of Management"—Sturgis & Walton), the matter presented appealing both to eye and to ear, the sequence being arranged according to the demand of the most efficient learning process.

This in no wise means discarding the usual text book and oral instruction common in teaching. It means supplementing these by projected drawings, and photographs, by stereoscopic photographs and by the usual type of moving picture, and "speeded up" or "slowed down" films, and by cinematographic line drawings—all of these being also used as consecutive lantern slides.

The motion picture film of commerce has been generally recognized as an admirable device for affording amusement and entertainment, and is coming slowly but surely to be appreciated as a demonstration, selling and instructing device. Education by films, however, demands in the maker of the films more than an experience in these lines. In fact, sometimes a too long experience of that character is a detriment. The aim of teaching films is not primarily to present an attractive picture. Neither can there be any of the usual "imitation" or "substitution". It must be realized that the film is not being used as a vehicle for making effects but as a vehicle for conveying actual facts and transferring skill and experience. It is necessary to think in different terms and with different ideals.

The films being used for the new education were utilized from their beginning from the educational standpoint. In our endeavors to find accurate methods and devices for recording the paths and times of motions, we experimented with the motion picture films as such a device, and as part of what we called the "micromotion process". In this the motion picture camera recorded on the standard films the activity studied, along with a cross-sectioned background recording distances and space, and a specially constructed microchronometer recording time. We have been making such micromotion records since 1912 in many fields, including intensive studies of the operation

and practical working details of several systems of management, among them the complete Taylor system. Of the latter we now have in film form the duties of each clerk in the office, and of each foreman and his assistants in the shop—of each member of the planning and production departments. Not only do the results of using these films in installing methods of management more than justify their cost—their value as records is significant. The complete system is shown as originally designed in such a manner that the measured data are available at any time. The films also show the pitfalls and mistakes that have appeared in some of the attempted changes that time has brought, and the reasons for and merits of changes that are improvements.

When the micromotion films primarily used as a record came to be used as a teaching device we added captions both within the same frames as the pictures and by themselves, without pictures, that pointed out or emphasized centers of attention and important facts to be noted. As the military films amply illustrate, the co-operation not only of the experts being studied, but also of expert teachers in the activity was enlisted, that captions as well as pictorial records might be of the highest grade of efficiency obtainable. Having developed the films into a teaching device and used them for teaching many groups of executives and workers in different lines of work, we then compared the teaching film carefully with the entertainment film of the moving picture house, in order to discover possible likenesses, and to utilize transferable elements of excellence. At the outset the films were made to record the motions and to present them to a selected worker to be trained, not to serve as instruction devices for large groups. It was a conviction of some of the pioneers in scientific management that greatest success would come through teaching one individual at a time. Later developments resulting in the installation of devices for teaching have proved the possibility, and in many cases the advisability, of training larger groups simultaneously. This is again exemplified in the films to be shown you. It is imperative because of the pressure for time and the need for a large body of trained men immediately, that the material be presented to large groups. Out of this need

has grown an adaptation of the film as a teaching device to group instruction, though there still remains the underlying idea that each individual trained will act as a center for skill transference, and will pass the material on to many others.

Not having lived through our long and strenuous experience with such films, you, in observing them, may naturally judge them as typical motion pictures and as showing war activities. This would, we hope, prove interesting, at least from a patriotic standpoint. However, if the films are to prove profitable, you should judge them as typical of such teaching devices and as applicable to all lines of activity in general, and to your own specific line of activity in particular. Only in so far as the films can approximate an efficient teaching process and furnish measured data are they of real value. Only in so far as you carry away a possible application to your own work have the films shown here done their required work in revolutionizing methods of education and in speeding up production in all lines of industry, while at the same time conserving and developing the human element.

We are at present putting into written form the fullest detailed instructions for the technic of the making and using of the films themselves. It has seemed best, however, not to wait for the completion of this material before bringing these subjects to the attention of audiences such as this, but rather to submit progress reports from time to time, that all those interested may make application along their own lines. The practice is fully worked out, much more fully in fact than these examples which we are today presenting you would indicate. In all our industrial films we include the microchronometer or speed clock in each picture, for purposes of records of comparative time of methods, as well as for time study. (See "Applied Motion Study".) We are constantly using and now have available thousands of feet of films similar to these, which we have used and still use as records and data for deriving standard methods, and as teaching devices in machine shops, foundries and factories; in offices and hospitals; in schools and even in the sports. The results have been first, making champions; second, and more important, increasing the skill of those already partially skilled in the activity, thus making possible

the completion of a large quantity of work of a high quality, or both; third, the transforming of unskilled workers into skilled workers; fourth, the realization that the difference between skilled work and unskilled work lies not so much in the requirements of the work as in the training of the worker.

Skill is dexterity plus brains. One can supply both muscle and mental training. It must be realized that this is the psychological moment for the introduction of the new method. Capital and labor alike realize the shortcomings of the older educational methods. All of us realize that the newer industrial ideals imply stabilizing industry, and we are beginning to realize that education is the great stabilizing and developing force. With the psychologists, engineers, educators and economists of the country leading the way toward such ideals, it remains for the industrial leaders—employers and workers alike —to embody these ideals in present day industrial practice. Skilled workers in metal and thinkers in metal are a vital part of the war program. They have shown themselves ready and glad to co-operate in supplying the fundamental necessities of successful warfare. If, however, you are to live up to your promises and your desires, you must place an equal emphasis on the development and utilization of our human resources. You have the plants, material and men and you have the brains. You have shown that you possess the desire to co-operate and the courage to gather together for discussion of common problems, that competition and progress may take place from the highest common ground. It remains but for you to realize that the work of your group, different as it may seem from that of others, has fundamental likenesses to such work, that the method of attack for obtaining the one best way to do work and the presenting of the one best way in the one best way that has proved successful in many other fields is applicable to yours as well. It has, in fact, been applied successfully to many, if not all, the elements that comprise your work. Back of the desired product, human and material, lies skill. It is our common task to see that more skill exists and that it is transferred more readily and as we realize this opportunity and obligation we shall the better prepare for successful war and successful peace.

The time has come when organizations and associations must do more than exist for offense and defense and meet for an interchange of ideas. The time has come when a great association must undertake the study of trade efficiency, as this cannot be done successfully by individuals, firms and corporations. The problem is too big and the duplication of effort makes the cost too great.

No association like yours can afford not to undertake the task of obtaining data for the one best way in each kind of work. In the international competition that will come after the war, that country that has the least waste in method and material will be the one that will be most successful. We have seen no trade activity that cannot be improved to a surprising extent both as to methods of working and methods of teaching. The time to begin the collection, measuring, sorting, synthesizing and teaching the one best way is now! To postpone the date of beginning is to help our enemies!

How Cost and Inspection Data Are Secured in the Foundry of the Naval Gun Factory

By Lieut. Walter S. Doxsey, Washington

Always closely allied with engineering progress, improved and accurate cost accounting systems are rapidly becoming as characteristic of modern foundry practice as the many labor-saving and cost-reducing devices which have been so widely introduced into progressive foundries during the last decade. The fundamental necessity of knowing in a general way the cost per pound of castings produced has been greatly accentuated by the advent of large scale production of standardized parts and by keener competition among foundries. These factors have served to emphasize the importance of reliable cost data and have brought the foundryman to look upon the accountant's tell-tale figures as a blessing rather than as a necessary evil.

War conditions have finally capped the climax for today it is not only highly desirable, but imperative, for the manufacturer to know definitely his manufacturing costs per unit of product. Contracts for the multifarious accessories of warfare have greatly increased the clerical work in foundries by requiring comprehensive inspection reports at various stages of production as well as demanding accurate systems of cost accounting. While the maintenance of such records imposes considerable additional duties and responsibilities upon the foundry superintendent, the value of these data is indisputable and indispensable. Furthermore, after a suitable system has been inaugurated, the recording of inspection and cost data becomes more or less mechanical and the clerical

work in a large foundry can be handled by a surprisingly small force.

Simple But Complete Records

The records maintained by the foundry at the naval gun factory, Washington, D. C., offer an example of the comparative simplicity of securing exhaustive data on the physical characteristics of the metal melted, the progress of work on the floor, and for computing the cost per pound of finished castings. In contrast to foundries devoted to the

S. D. No. 35

Oct. 15. 1918
Probable date of completion of order

Extended to

WASHINGTON YARD

JOB ORDER NO. 8-Z-38165.

Title Z

Issued July 11. 1918.

Appropriation O. & O. S.

Completed

Authorized by N.G.F. #622/30

SPECIFICATIONS

A. L. WILLARD

Make 3 sets of loading device for 14" inch mount.
List of drawings. Sketch 7441.

URGENT

Mr. Lynch will see that all work necessary for the proper completion of this job is undertaken and upon completion will sign here.

COPIES OF THIS ORDER HAVE BEEN SENT TO	MATERIAL IN STORE
Mr. Lynch Desk "E" Accounting Office Planning Division Assembling Division	None

FIG. 1—JOB ORDER FORM FOR PLANNING DIVISION

highly specialized production of a few types of castings on large contracts, the naval gun factory foundry turns out a widely diversified assortment of castings in gray iron, steel and brass, varying in weight from a few ounces to several tons and from the most simple to those of utmost intricacy. Although this condition tends to complicate the maintenance of records, specific data on the wide range of products are secured expeditiously with a minimum of clerical work. While the system in use at the naval gun factory foundry is applied to steel, brass and iron foundry practice, the following description is devoted only to the steel foundry

and shows how data are gathered in the foundry for the foundry files, the inspector and the accounting office.

Dividing the Work

Records of inspection, estimating and cost accounting pertaining to the manufacture of ordnance material at the naval gun factory are supervised by three separate, yet interlocking, divisions: The planning division, the inspec-

N. G. F. No.

MATERIAL LIST.
CASTINGS.

Job Order No. 8-Z-38165 — Estimate No. 5-14-178 — Prepared by R.C.H.

Shop E Date July 15, 1918 For Loading Device for 14-inch Mount

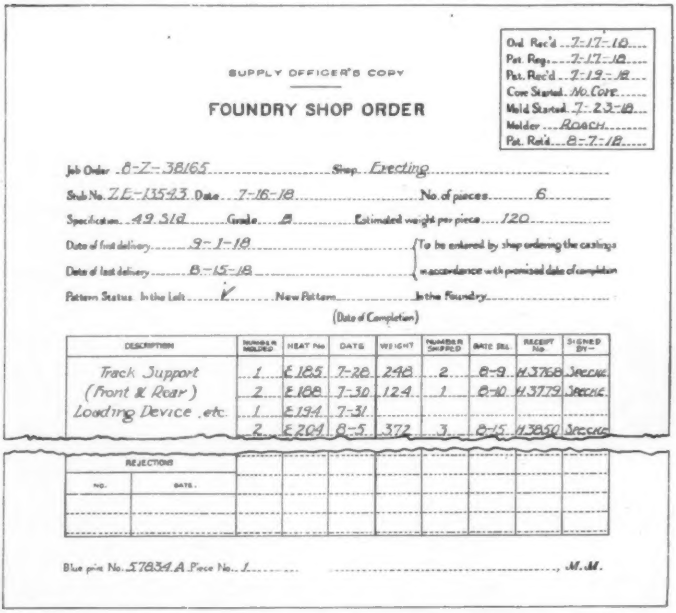
Drawing No.	Con.	Piece No.	No. Req'd	Name of Castings and Material or Quantity and Description of Material	Specifications	Symbol	Rough Wt.	Price per lb.	Req'n No. Stk.	Req'n No. Scrap	Pattern	Labor	Material
57832	A	1	12	Tray wheels Steel, Grade B	49 Sld	Dr.	10#	.09	13537	None	C	4.88	10.80
57832	A	2	9	Track Roller Steel, Grade B	49 Sld	Dr.	15#	.09	13538	None	C	6.57	12.15
57834	A	1	6	Track Support									
				Front & Rear Steel Grade B	49 Sld	Dr.	124#	.09	13543	None	C	17.52	66.96
57834	A	6	3	Track Support-Intermediate									
				Steel Grade B	49 Sld	Dr.	124#	.09	13544	None	C	8.76	33.48

FIG. 2—MATERIAL LIST FOR CASTINGS ORDER

tor of ordnance, and the accounting office. The functions of these divisions are indicated perfunctorily by their respective names. Orders for material, which have their inception in the superintendent's office are sent to the planning division where subsidiary orders are issued to the shops that will execute the various operations of production. Thus, if the superintendent issues an order for a new gun carriage, the planning division will send subsidiary orders to the pattern shop, the foundry, and the machine shop. The accounting office is responsible for accurate data on the

cost of the work done in the shops on each individual order and the inspector sees that the quality of material and machine work is in accordance with the navy department specifications under which all ordnance is manufactured at the naval gun factory.

Orders originating in the superintendent's office are sent to the planning division on a job order form similar to the



SUPPLY OFFICER'S COPY

FOUNDRY SHOP ORDER

Ord Rec'd 7-17-18
Pat. Req. 7-17-18
Pat. Rec'd 7-19-18
Core Started No Core
Mold Started 7-23-18
Molder Roach
Pat. Ret'd 8-7-18

Job Order 8-Z-38165 Shop Erecting

Stub No. ZE-13543 Date 7-16-18 No. of pieces 6

Specification 49 S1d Grade B Estimated weight per piece 120

Date of first delivery 9-1-18 } To be entered by shop ordering the castings

Date of last delivery 8-15-18 } in accordance with promised date of completion

Pattern Status In the Loft ✓ New Pattern In the Foundry

(Date of Completion)

Description	Number Molded	Heat No.	Date	Weight	Number Shipped	Date Del.	Receipt No.	Signed By—
Track Support	1	E 185	7-28	248	2	8-9	H 3768	Specke
(Front & Rear)	2	E 188	7-30	124	1	8-10	H 3779	Specke
Loading Device, etc.	1	E 194	7-31					
	2	E 204	8-5	372	3	8-15	H 3850	Specke

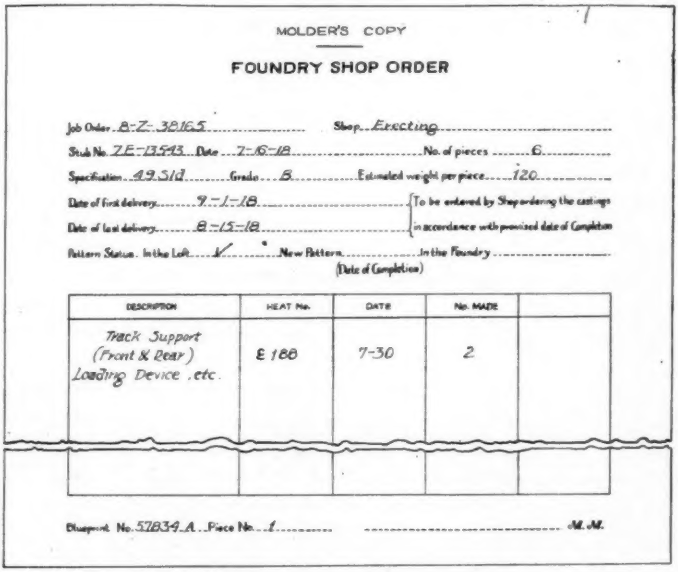
Rejections	
No.	Date.

Blue print No. 57834 A Piece No. 1 , M. M.

FIG. 3—FOUNDRY SHOP ORDER—SUPPLY OFFICER'S COPY

one shown in Fig. 1. On this order is included all the information necessary to identify the article to be made and to enable the planning division to route the work properly through the shops for manufacture. While the functions of this board in relation to the departments of the gun factory are most interesting from the shop management viewpoint, a detailed description of its work is beyond the scope of this article.

When the planning division receives a job order requiring castings, a material list, as shown in Fig. 2, is prepared. This list shows the various castings required by the order. Under the head "pattern" on this form is placed a character which shows the status of the pattern. The estimator, who is a representative of the planning division, confers with the foreman of the foundry and from the blueprints of the cast-



MOLDER'S COPY

FOUNDRY SHOP ORDER

Job Order 8-Z-38165 Shop Erecting

Stub No. ZE-13543 Date 7-16-18 No. of pieces 6

Specification 49 S1d Grade B Estimated weight per piece 120

Date of first delivery 9-1-18 } To be entered by Shop ordering the castings

Date of last delivery 8-15-18 } in accordance with promised date of Completion

Pattern Status. In the Loft ✓ New Pattern (Date of Completion) In the Foundry

DESCRIPTION	HEAT No.	DATE	No. MADE	
Track Support (Front & Rear) Loading Device, etc.	E 188	7-30	2	

Blueprint No. 57834-A Piece No. 1 M. M.

FIG. 4—FOUNDRY SHOP ORDER—MOLDER'S COPY

ing figures the cost of the metal per pound of the finished piece. This estimate is divided into items of material and labor and entered in the proper columns of the material list. While the estimated cost is not held as an absolute criterion of the value of the finished casting, the final exact cost as computed from the foundry data sheets by the accounting office must be within 10 per cent of the estimated cost or an investigation is made to determine the discrepancy.

STEEL FOUNDRY
MOLDING REPORT

Reported by S. A. HIGGS — Date 7-28 1918

Core Check	Mold Check	Stub Number	Description	BPT.	Pc	G T	No Made	Wt.	M P
None	178	7E 13543	Track Support	57834	1	B	1	124	✓
None	178	R 764	5" B. M. Carrier	54774	1	B	1	167	✓
222 A	141	U 401	Director Stand	55239	1	B	1	95	✓
None	151	U 109	Torpedo Door	40717	1	B	2	100	

Super. Molding F. S. S. Shift 8 to 4

FIG. 5—FORM FOR MOLDING PROGRESS REPORT

STEEL FOUNDRY
POURING REPORT

Reported by S. A. HIGGS — Date 7-28 1918

Core Check	Mold Check	Stub Number	Description	BPT	Pc.	G R	No. Made	Wt.	
None	178	7E 13543	Track Support	57834	1	B	1	124	✓
None	178	R 764	5" B. M. Carrier	54774	1	B	1	167	✓
222A	141	U 401	Director Stand	55239	1	B	1	95	✓
None	151	U 109	Torpedo Door	40717	1	B	2	100	

Super. Dry Floor C. A. E. Shift 4 to 12 Metal held in ladle 8 Minutes

Poured by J. B. E. Melter SCOTT Heat No. E 185

FIG. 6—POURING REPORT

After estimates have been made and dates of delivery determined with due consideration for the immediate need for the castings and with proper cognizance of the prevailing conditions in the foundry, subsidiary or foundry shop orders are written by the planning division for each casting. These subsidiary orders contain all the information and authority necessary for a shop to proceed with the work required. The foundry shop order, as may be seen by referring to Fig. 3, is similar to the superintendent's order, Fig. 1, but is more comprehensive and embodies the additional information furnished by the planning division. The supply officer's copy shown in Fig. 3, is the original; the other five, one of which is illustrated in Fig. 4, are carbon copies and are distributed as follows: Foundry file copy, molder's copy, coremaker's copy, accounting office copy, and machine shop copy.

The original, or supply officer's copy, as shown in Fig. 3, is filled for illustrative purposes similar to an actual order. The legends preceding the blank spaces and at the heads of the columns are largely self-explanatory. The "job order" number is the same as the one entered on the superintendent's order and serves to identify the subsidiary with the original order. After the word "shop" is filled in the name of the shop to which the castings are to be delivered—in this case, the machine shop. The "Stub No." is a serial number individual to foundry orders. Since, as previously mentioned, all the ordnance manufactured at the naval gun factory is made in accordance with navy department specifications, the foundry is instructed to make the castings on this order as outlined in the specifications for steel castings indicated by the characters 49*Sld*. The chemical and physical requirements for the various grades of metal included in these specifications are embodied in Table I.

Supply Officer's Records

The first three columns of this form are filled in by the supply officer's clerk who makes entries on the record from information contained in molding and pouring reports. As the finished castings are delivered, the last five columns are

filled by the shipping clerk. With each lot of castings delivered a supply officer's receipt is forwarded. This must be signed by the recipient and returned to the foundry when the number of the receipt and the name of the recipient are entered in the last two columns. The heading "Receipt No." over the next to the last column refers to this receipt. The supply officer's receipts are marked "partial" or "com-

STEEL FOUNDRY—MOLDS POURED.

Heat No. E 185   *Date,* July 28, 1918

Furnace loss, 929   *Pigs returned,* 6623

Pig Iron #	Pig Iron #	Own Scrap.	Foreign Scrap.	Fe. Mn.	Fe. Si.	Wash. Metal.	Alum.	Ore.	Other Shells	Electrode	Total Melt.
		2000	10500	100	270		4	400	240	1	13274

Stub No.	Molds Poured	Molder's Tag No.	Name of Piece.	Grade	Bpt.	Pc.	Wt. of Castings.	Wt. of Heads & Gates	Wt. of Defectives.
ZE 13543	1 {	56092	Track Support	B	57834	1	124		
R 764		56092	5" B.M Carrier	B	54774	1	167		
U 401	1	56096	Director Stand	B	55239	1	95		
U 109	2	56126	Torpedo Door	B	40717	1	200		
							5722	6000	623
			C Mn P S Si Cu Ni Cr .20 .84 .023 .020 .19 .48 .50 Trace						

FIG. 7.—FINAL RECORD OF CASTINGS MADE FROM SINGLE HEAT

plete" to indicate to the recipient whether or not more castings are to be expected. It also furnishes the master mechanic of the machine shop with data to enter on his copy of the foundry shop order.

When the supply officer has made the proper entries from the receipt upon his foundry shop order, the receipt is sent to the accounting office. As these receipts are received by the accounting office, they are filed under the stub number of the subsidiary job order and when a receipt marked "complete" is finally received, the accountant is thus automatically informed that all the foundry work on the order

is finished and proceeds at once to compute the costs. When the foundry costs have been determined, the charges are entered against the original job order, a copy of which is sent to the accounting office by the superintendent.

Time of Coremaker and Molder

In order to secure a record of the actual time spent by the coremaker and the molder upon any one casting, they are given copies of the foundry shop order which they use for reference in filling out their time cards. These time cards bear the foundry shop order serial number. As they are turned in, they are sent to the accounting office where the time is charged against the job. It is through this means that the direct labor costs are accurately determined and properly charged. These same time cards are also used to compute the pay of the coremakers and molders.

The fifth copy of the foundry shop order is turned over to the foreman, who upon receiving it, places it on a file among other new work to be taken up. Once the job is started, this copy is transferred to a file of work under way. Through this means, the foreman knows precisely at all times the exact status of the work in his foundry.

For the information of the master mechanic of the machine shop a sixth copy of the foundry shop order is supplied for his files. It is on this copy that he enters the data from the supply officer's receipt. This copy not only shows when deliveries are in arrears, but also serves to indicate the number of castings he may expect for machining in the near future.

Report of Work in Progress

Fig. 5 shows the form which is used to secure data on molding in progress on the foundry floor. The record of each flask is identified with the foundry shop order by entering the serial number of the order in the column headed "Stub No." Further identification is contained in other columns which give a brief description of the casting, the blueprint and piece number, the grade of metal to be poured into the mold, and the number of castings in the flask. In

the first column is entered the number of the coremaker whose cores are used in the flask. These numbers are scratched on the cores by the coremakers and are copied onto the molding report by the clerk before the flask is closed.

Molders are given brass checks bearing numbers individual to each flask. Before the molds are baked, these checks

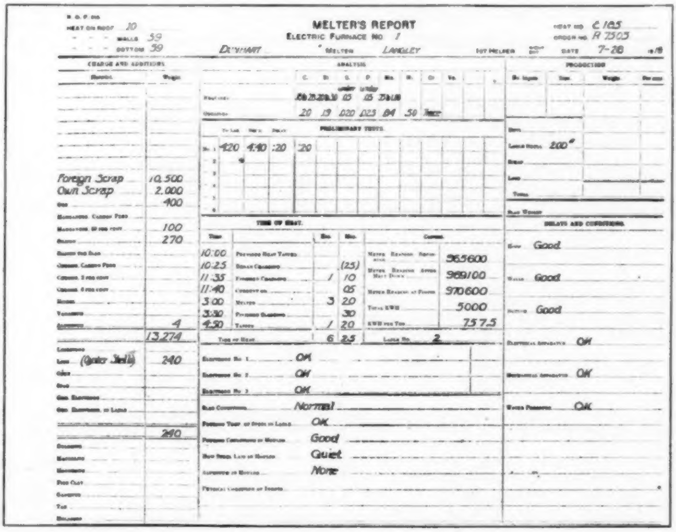
ELECTRIC FURNACE

	Expenditures					
Date	7-28-18					
Heat No.	E185					
Pig Iron						
Silicon	270					
Aluminum	4					
Ferro Manganese	100					
Iron Ore	400					
Heads & Gates	2000					
Nickel Shavings						
Monel New						
Monel Shavings						
Nickel Scrap						
Carbon Scrap	10500					
Carbon Shavings						
Money Plata						
	Receipts					
Good Castings	5722					
Defective "	623					
Heads & Gates	6000					

FIG. 8—CHARGING RECORD

are tacked on the flasks and their numbers are properly entered on the molding report. After the molds have been been baked and are ready for pouring, reference to the brass checks and molding report shows the grade of metal from which the castings are to be made. As a heat is poured, the brass checks are removed from the flasks and sent to a clerk who checks the extreme right-hand column on the molding report. These checks show exactly what castings have been made from a single heat.

After a heat has been poured, the data concerning cast-


MELTER'S REPORT

ELECTRIC FURNACE NO. 1

Foreign Scrap 10.500
Own Scrap 2.000
400
100
270
4
13.274
(Oyster Shells) 240
240

10:00
10:25
11:35
11:40
3:00
3:30
4:50

365600
369100
370600
5000
757.5

Good
Good
Good
OK
OK
OK

Normal
OK
Good
Quiet
None

FIG. 9—RECORD OF EACH HEAT KEPT BY MELTING DEPARTMENT

ings made from that heat are transferred from the molding report to a pouring report which is shown in Fig. 6. This pouring report constitutes a preliminary record of single heat and carries a heat number assigned by the furnace attendant. The molding and pouring reports are filed for foundry reference.

As soon as the pouring report is made out by the clerk, a copy is sent to the annealer. The annealer's copy is placed

in his hands before the molds are taken to the sand pile. As the castings are knocked from the flasks, the annealer, or rather his helper, refers to his copy of the pouring report to identify the castings and stamps the heat number on them, thus assuring the identity of each casting with the heat from which it was poured.

Following Up Each Heat

The final record of castings made from a single heat is shown in Fig. 7. The descriptive data relative to the cast-

N. O. F. 304.

REPORT OF ANNEALING.

Heat No. E185 Furnace No. 2 Readings
Furnace fired 8.00 A.M. 8-1-18 Heat up 12.00 M. Temperature 1450°
At heat 3 hours. Closed 3.00 P.M. Cover removed 12.00 M. 8-2-18
Time cooling 21 hours. Relighted Temperature
Heat up Temperature At heat hours.
Closed Hours cooling Operator SMITH

REMARKS.

NO.	NOMENCLATURE.	HEAT NO.	NO.	NOMENCLATURE.	HEAT NO.
ZE 13543	Track Support	E 185			
R 764	5" B.M. Carrier	E 185			
U 401	Director Stand	E 185			
U 109	Torpedo Door	E 185			

FIG. 10—ANNEALER'S REPORT

ings agree with that on the pouring report. In addition to these data are entered the constituents of the furnace charge constituting the heat. The "furnace loss" consists of the total weight of the charge less the total weight of the good castings and pigs returned. The weight of the heads and gates plus the weight of defectives gives the weight of "pigs returned". These data are sent to the foundry office by the supply officer who issues the raw materials. Duplicate copies of the steel foundry-molds poured

report, Fig. 7, are distributed as follows: Foundry files, accounting office, inspector and shipping clerk.

The necessity for identifying each casting with the heat from which it is poured is twofold: The cost per pound of metal in the casting is dependent upon the cost of the materials which enter into the heat; for an intelligent analysis of the physical and chemical characteristics of test coupons taken from the casting, the inspector must know the exact

N. G. F. 292

TEST OF Track Support — File No. 21792

Casting ~~Forging~~ Grade B — Specification No. 49 Sld — Stub No. ZE13543

Heat No. E 185 — ~~Ingot No.~~ ~~Billet No.~~ — Job Order No. 8-2-38165

Drawing No. 57834 Pc 1 Call No. — Requisition No.

	CHEMICAL ANALYSIS							
	C	Si	P	S	Mn	Cu	Ni	Cr
Gov't Requirement								
Contractor								
Government	.20	.19	.023	.020	.84	.48	.50	Trace

HEAT TREATMENT

Annealing
Temp. of Soaking 1450°
Hours of Soaking 3
Hours to come up 4
Hours Cooling 21

Date 8-15-18	Heat No.	Size of bar	Yield Point	Tensile strength, pounds per square inch	Per cent of elongation	Per cent of reduction	Rupture stress, pounds per square inch	Cold bend	Fracture	Remarks
Requirements			45% of T.S.	60,000	22	30.0		120°		
	E185	0.50	40,100	68,200	23.5	34.8		120°	Cup ½	OK

FIG. 11—INSPECTOR'S REPORT

constituents of the heat. As the furnaces are charged, a record is made out as shown in Fig. 8, on which is entered the weights of the raw materials in the charge, the number of the heat and the date. Separate records are kept for the electric furnace, the converter and the open-hearth furnace. These reports of materials charged are turned over to the supply officer who totals them for entry on a monthly report of charges into each furnace. At the end of the month, these reports are sent to the accounting office where the cost per pound of metal is computed. A memorandum of the constituents of each charge is sent to the foundry office where the data are noted on the record of castings made from a single heat as shown in Fig. 7.

In addition to making out a record of the constituents of each charge, the melting department also keeps a log of each heat which is forwarded to the inspector upon its conclusion. The method employed in keeping this log and the data recorded are readily understood by referring to Fig. 9 which is a record of a typical open-hearth furnace run.

The influence of annealing upon the characteristics of steel castings is such an important factor that the annealer is

Table I

CHEMICAL AND PHYSICAL REQUIREMENTS FOR STEEL CASTINGS

(Taken from Navy Department Specifications 49Sld.)

	Chemical Composition Not over		Physical requirements				
			Minimum tensile strength	Minimum yield point	Minimum elongation	Minimum reduction of area	Bending test; cold bend not less than
Grade	P.	S.	*Pounds per square inch.*	*Pounds per square inch*	*% in 2 in.*	%	
F....	0.05	0.05	85.000	53,000	22	35	120° about an inner diameter of 1 in.
A....	.05	.05	80,000	45 per cent of tensile strength obtained.	17	20	90° about an inner diameter of 1 in.
D....	.05	.05	70,000		22	30	120° about an inner diameter of 1 in.
B....	.06	.05	60,000		22	30	
C....	.06	.07	.....	....	..	..	Do.

NOTE.—Class F castings may contain nickel or other alloying metals.

required to furnish the inspector with an accurate account of the treatment of each casting. These data are entered on a form, Fig. 10, which lists the castings, their heat numbers, and the treatment to which they were subjected in the annealing furnace. Pyrometer readings taken during each run of the annealing furnace are sent to the inspector as a check on the data entered on the annealing report. The test coupons are removed and sent to the machine shop to be prepared for the laboratory. The direct or labor cost of this machine work is sent to the accounting office to be charged against the foundry shop order.

Coupons taken from castings are tested in the physical and chemical laboratories to ascertain if the casting is in

accordance with the specifications on the original order. The inspector accepts or rejects the castings and sends to the foundry for its information a report of the tests on a form similar to the one shown in Fig. 11. If the laboratory tests of the coupons prove unsatisfactory, the history of the metal may be traced through the log of the furnace, the steel foundry-molds poured report, and the annealer's report which the inspector has in his office. If further investigation is desired the names of the molder and the coremaker and any other desired information can be obtained from the molding and pouring record.

A resume of the foregoing shows the data furnished the accounting office for computing the cost per pound of the castings. Direct labor costs are figured from the time cards of the coremakers, the molders, the cleaners and others whose work is directly associated with the production of the castings. These cards bear the number of the subsidiary or foundry shop order and give the actual number of hours of labor as previously explained. Costs of material are computed from the records of materials charged into the furnace which are furnished by the supply officer. Accurate account of materials and supplies used in the foundry which do not enter directly into the castings, such as oil fuel, furnace brick, etc., and indirect labor costs, such as floor cleaning, crane operation, etc., is kept through copies of requisitions for supplies and time cards which are sent to the accounting office from the foundry. Other indirect charges such as depreciation of the building and tools, and equipment maintenance and replacement are combined and proportioned equitably in conjunction with the direct charges for labor and material in determining the final cost per pound of the casting.

The Commerce of Coke

By J. A. Galligan, Chicago

Business methods developed during the war will affect customs after the war has been won. A lasting lesson, I daresay, will be found in the desirability of saving transportation of raw and semifinished materials wherever possible. It will be a matter of necessity for several years, as the railroads will be almost as hard pressed to handle the enormous volume of peace traffic as is now the case with war products.

A few years ago the saving of transportation had no place in our economic thought, while today it is of great importance. The nation's transportation facilities must be conserved to the utmost as there is not comfortable room for all freight movements, even though the railroad administration has helped the situation materially by eliminating many passenger trains, diverting the engines thus released to freight traffic. Loading of freight cars to full capacity and routing freight by the most direct routes are among some of the other saving measures adopted. All these moves are doing much to relieve the strain on our transportation facilities, but there is no room on the rails for any unnecessary freight movement. This condition has fostered and promoted the conduct of business near home, and while the present necessity of doing business near home is forced by government wishes and transportation shortage, the substantial and many benefits of near-home business will be appreciated long after transportation demand and supply become nearly equal. I believe the mutual advantages of home trading will by that time have been clearly demon-

strated and only unfair dealing by short-sighted people will bring an end to the reciprocal service and benefit the home market can afford both buyer and seller.

Home Market Important

The home market is of greater importance usually to the buyer or consumer than to the seller, and this is particularly true in the case of coke, on which subject I have been given the honor and privilege of addressing the American Foundrymen's association. Coke, being a bulky product, has been restricted by the United States fuel administration to consumption in zones nearest production, and in this measure lies a lasting benefit to coke producers and foundrymen. The coke manufacturer as a rule has a territory to draw from in which consumption exceeds production, but the alert and prudent coke man will cultivate and foster home business always as against distant tonnage, although the price return is usually the same. Because of the phenomenal development of by-product ovens in the past few years, more especially the past two years, I shall confine my remarks to that class of fuel.

It seems but a very short time ago when by-product coke was looked upon by foundrymen as unsuitable for cupola fuel, and a thing to be avoided. The different appearance of by-product coke was responsible to a great degree for this prejudice. Coke from by-product ovens was not taken seriously as a real metallurgical fuel, because it appeared to be everything that the so-called standard beehive coke is not, and apparently had nothing to replace the many excellent qualities that the beehive coke possesses. Foundrymen thought there could be no real comparisons and that the two classes of coke were different things, and therefore, could not be considered together. If these views had been correct the history of the by-product coke oven would have been completely written before this time. It was not until 1897 that the production of by-product coke in the United States be-

gan to be a noticeable curve on the total coke production chart.

On Aug. 1, 1918, only two decades later, the production of by-product coke, plus the capacity of by-product ovens then building, was equal to the beehive coke production as of Aug. 1, 1918. It is estimated that the production curve of by-product coke will cross the beehive curve before the end of 1918 and when this is accomplished it is doubtful if beehive production will ever again equal by-product tonnage. The vast increase in government requirements for by-products as well as coke, has hastened the installation of many by-product oven plants that ordinarily would not have been built so soon, but the natural development of the by-product industry would have crossed the curves in a very few years by a continuance of the prewar increase. The needed increase in coke production could hardly have been accomplished through the beehive type of oven, as coal tonnage is available for by-product oven use that the beehive type cannot coke satisfactorily. The modern by-product oven has had its development in the short space of 20 years. It is assuredly all modern, even including the types that the coke master of today considers out of date. The most pronounced change and improvement has been in size, the 4½-ton capacity oven of 20 years ago having grown to a 15 and 20-ton capacity oven in the most recent installations, yet the small ovens are in some cases still performing their daily tasks in a most creditable manner.

The presence of a by-product coke plant is a pronounced asset to adjacent foundries and should be the source of their coke supply if it can be arranged. Foundrymen should get in close touch with the new ovens and see that the best coke for their purposes is produced. Do not leave all the work of experimenting in the hands of the coke man. Be a party to the development of a suitable product, and do not expect to withhold your support until the ovens are producing exactly the kind of coke you want or need. The foundryman does not know in many cases what is wrong with a certain coke which may not suit him and therefore it is difficult for him to do much real co-operating in its improve-

ment. If the foundryman, however, has the real spirit of co-operation and interests himself in working the problem out, he will at least get some very valuable information and will also probably get a better coke.

Coal Mixtures a Factor

In the case of some ovens, the most favorable branch of trade may be other than foundries, for instance, blast furnaces. A good blast furnace coke is not always a satisfactory cupola coke. A change in coal mixtures may be necessary to get the right foundry product. The volume of available foundry tonnage may not be sufficient to warrant or permit constant operation of a portion of the coke plant on foundry coke. Foundrymen should then group their orders and have the coke plant make special runs for them on designated days, if such a thing can be arranged. The ovens may be located where the disposition of undersized coke is difficult or impossible. In this case the foundryman should not exact the usual foundry screening, but accept run-of-oven coke and use the small coke in core ovens, etc.

I have presented this matter on the theory that ability to obtain coke near home is of more advantage to the foundryman than his patronage is of value to the coke plant, and this is true in a great many instances. The foundry consumption is less than 10 per cent of coke production, so it is apparent that cupola tonnage is not of great importance to some coke plants, while ability to obtain a coke supply nearby is an asset to the foundryman. He is the one to suffer from delays in transit, etc., not the shipper.

Why Does Coal Coke?

For those ovens making a specialty of foundry coke no urging by the foundryman should be necessary and generally speaking it is not. All possible care is taken in the selection of proper coals for the character of the coke depends largely upon the character of coal or coals used to produce it, as well as the degree of heat and the method of applying it. Considerable investigation has been made upon the subject of what makes coal coke, but it is not yet certain what controls

this. A French chemist, M. Lemoine, has isolated a substance which he calls "carbene," and which he thinks is the real essence. The bureau of mines of the United States has conducted extensive experiments and written the story of its conclusions, but after all not much is known about the subject. The only way to determine it satisfactorily is by test, when it is found some coals will coke and some will not.

While the precise coking substance is not known, it is recognized in general that the resins that were contained in the original vegetable matter from which the coal was formed constitute the cementing body necessary in the manufacture of coke, and the presence of the proper percentage of these resins is essential for the coal to be of good coking quality. When there is an excess of these resins as in the fatty gas coals, a good coke can be made by adding a proper percentage of a coal which is deficient in the resins, and which perhaps has other advantages such as a low ash or a low sulphur content.

All coking coals will not mix, for coals are like people —some do not take well to others. For two coals to coke together well, it is important that they should be coals which become plastic at practically the same temperature With the modern by-product oven it is possible to produce good coke from coals that were formerly considered inferior. The modern plan involves the mixing of coal so as to correct with one coal the deficiencies that may exist in one or two others. The value of this method as an aid to the conservation of our natural resources is at once apparent, for the nation's supply of the best coals is quite limited.

It is not my purpose to treat of the science of coke making. Foundrymen will find the by-product coke manufacturer, who is interested in foundry tonnage, anxious to make the best foundry fuel possible. The interest of foundrymen and coke manufacturers in home trading should be mutual and let us hope each may strive to help the other.

Discussion—The Commerce of Coke

MR. J. A. GALLIGAN.—Now, gentlemen, while I am here I want to say a word to you on the general coke situation and the general coal situation of our country. You are naturally concerned about your supply of coke for this winter; and I can say to you with confidence that, speaking of the country generally, I believe the foundries are going to be sufficiently supplied; and in some sections of the country—and I am glad to say the west is one of those sections—we look for an ordinary winter, and a fair volume of tonnage.

The subject of coal is of such bulk and vastness that we sometimes do not comprehend it. We are accustomed to put problems up to the United States, no matter what their magnitude, and expect the country to absorb or digest them; and, generally speaking, we can do that. But coal is of such bulk that there are decided limits to what is possible in the handling of it, and in the mining of it. I have heard it stated, and I believe it to be a fact, that 52 per cent of the railway equipment of the United States is now engaged in the handling of coal. We mined last year 100,000,000 tons more coal in this country than in 1913. If everything were to go along this year in this country as we want it to go, we would need 100,000,000 tons more than we did last year. Despite the fact that we have less men in the mines on account of the necessity of army building, we will produce this year 50,000,000 tons more than a year ago; and it is intended that the remaining 50,000,000 be obtained by conservation; 35,000,000 tons from industries, and 15,000,000 tons from homes.

To give you some idea of the coal traffic in this country: you will recall that in normal times each fall, when we have the car shortage, the explanation is made that we are moving the wheat crop, and we all understand then why cars are short, because that is a big job. The coal traffic of the United States amounts every eight days to a total equal to our

yearly wheat crop. Every one and a third days we move a tonnage of coal equal to the cotton crop.

Visualize this thing a little bit more. Last year's coal production was the equivalent of excavating two and a quarter Panama canals—not from the surface, but away down from the depths of the earth. And when you consider that the average transportation of coal in the United States is 300 miles, it means that we dug that canal two and a quarter times in a year and dumped it not in a gulley, or wherever there was a handy place to dump it, but we distributed it in hundreds of thousands of different spots, just where it was needed, and almost every hour just when it was needed.

There was some shortage, but the distribution plan this year is in good working order, and I think the fuel situation of the country is well in hand. Of course, there are some sections of the country that require such a tremendous volume of fuel that it is almost impossible to have it right at the spot needed.

Take our own little county of Cook, Illinois. This may be a surprising statement to many of you. There is approximately as much coal used in Cook county annually as there is in the New England states combined. The consumption of coal in the New England states last year was a trifle over 31,000,000, and there were 30,000,000 tons used in Cook county, 25,000,000 by industries and 5,000,000 in homes.

When 30,000,000 tons of material is brought into an area of 200 square miles, it is not to be expected or presumed that it can be done perfectly.

The same condition obtains in other sections of the country, no doubt, with which I am not so familiar, but, gentlemen, generally speaking, the fuel situation of the country, I believe, is in good hands, and is quite well mastered. But it is a substance of such bulk that there are decided restrictions to it. There is nothing to fear, however, because the men in the mines are showing the right patriotic spirit, mining more per man than ever before; and the same is true of the laborer around the coke plants. The same is true of the railroads, in transporting; they are giving us excellent service. Everything seems to be working well together; and, while

we do not look upon the approach of winter with any calm feeling at all—because there will be winter difficulties to contend with—I think the flag is flying high and it is going to stay there.

THE PRESIDENT, B. D. FULLER.—I am very glad that Mr. Galligan has been with us this morning to give us his personal impressions of the vastness of the subject. There is one little point that I would like to speak on for a moment myself. Mr. Galligan asks that where possible foundrymen use the furnace coke, taking it as it comes from the furnace, with the view, of course, of saving manpower, and the conservation of material.

I would like to call Mr. Galligan's attention, from the foundryman's standpoint, to this fact, that this is being done: Ovens are shipping their material to the foundrymen, and the foundrymen are willing to co-operate in this; but when small coke goes into a cupola, and I speak from experience, it will slow up your heat, and you will have a loss in a batch of castings which you would not otherwise have. That is wasting manpower and losing castings and slowing up production on our end.

I would urge upon those ovens that are going to ship our foundrymen this material, that they install a screen which will give us coke for foundry purposes, thereby saving that manpower and increasing production from our end; which I believe will overbalance the other point.

MR. J. A. GALLIGAN.—Mr. President, my remark on that point was predicated on the conditions in the south where, for instance, there is no market for undersized coke, in the way of domestic fuel. If a foundry is located adjacent to such a coke plant, my point is that it would be well for that foundry to arrange for its coke supply there, and do its own screening, and use the smaller coke in its core ovens, rather than go to a coke oven plant at a distance, which will give it the properly screened coke. The condition, of course, in the north is balanced by the fact that there is a market, and a ready market for all undersized coke. It is simply a matter of screening it and shipping the big coke to the foundries, and the screened undersized to fuel dealers, or to the brass

foundries, or similar industries. But conditions in all parts of the country are not so fortunate. If there is a good coke plant near you, that is the coke to get. Nearness of supply is a great item.

MR. A. C. DENNISON.—I have been using by-product coke all summer. I would like to ask if it is your experience, and that of any others here, that you find it takes a little more by-product coke to run your cupola than it does the other? I find, using the same quantity, I could not get the same result. I got good iron with the by-product coke, but I had to use a little more of it. Now, possibly something was wrong with the coke. I would like to know whether that is the general experience.

MR. J. A. GALLIGAN.—No. The general experience is the other way.

MR. A. C. DENNISON.—That is what I heard; but it is not so in my case.

MR. J. A. GALLIGAN.—Because it is possible to make a higher carbon fuel in by-product ovens from the same coal; because there is no loss of fixed carbon in the by-product coking process.

MR. A. C. DENNISON.—I understood that, but it did not work out that way. I had to increase it a trifle.

MR. J. A. GALLIGAN.—Foundrymen are finding generally that it takes a little bit more coke to melt their iron now. My personal opinion on that score is that it is due to the fact that our irons are lower in carbon, and consequently have a higher melting point and they absorb carbon from the coke.

Co-operation Between the U. S. Railroad Administration and the Foundry Industry

By EDMUND D. BRIGHAM, Duluth, Minn.

These are the days of thorough co-operation between all loyal citizens and, as never before, a man, or body of men, who will not co-operate to "win the war" is no patriot.

You have heard much recently of co-operation, co-ordination and consolidation, especially since the government assumed control of the railroads of the United States. During this brief period, we, who are engaged in it, feel that much has been done and accomplished, and we are going to do more. We certainly could not have gone along as in the old way, "going it as you please," as were also many branches of industry.

We have learned to co-operate more each day and find that the more we do, the better it is for each of us, individually, collectively, and for the corporation we are privileged to represent.

One of the greatest benefits we at home will derive for the great sacrifice being made "over there" will be in the end everlasting peace and the defeat of ***Prussianism***. And it will be largely because of this co-operation here, and with those faithful allies who are fighting this great battle with us.

The iron industry of the country, which you men here represent, is one of the largest, if not the largest, contributor to the railroad administration revenues. You men, administrating the affairs of this great industry, have always been most willing to co-operate and more especially have you done so during this period of government control of railroads. We know you have suffered much, so have we all. When other

business than yours has been given priority movement, you have had to wait, and often with great money loss, and you are accepting it gracefully.

The advanced rates recently established on freight and passenger traffic, the people of the country have accepted most graciously, and with hardly a protest. They will now very soon begin to receive the benefits of some of this increased revenue, as the administration is making many improvements not otherwise possible. We must first, however, send to Europe for that great American army thousands of cars and locomotives, and when this has been done, the roads here will be given their requirements.

The railroad administration is doing everything it possibly can to maintain the old standards, but it is first taking care of Uncle Sam's needs, and after that the public. This is one of the messages I bring to you from Regional Director Aishton, in charge of the northwestern region. Many of you know him personally for he was president of the North-Western railroad prior to being appointed by Mr. McAdoo to his responsible position. He is now on the Pacific coast, traveling day and night, endeavoring to instill into that large army of men under him, this thought.

You will all recall what we had to contend with last winter; the service was bad; and because of lack of preparation, there was great congestion on nearly all railroads. Many of them under private operation didn't have the money to purchase cars and engines and even fuel, and could not get it because they could not advance their revenues. For this reason they were helpless.

This condition not only brought about actual suffering for want of coal, but it most seriously blocked the transportation of supplies going to the factories and the front.

We will see no repetition of it this winter. Under Mr. McAdoo's orders, and his co-operation with Mr. Garfield, the coal question is solved. You will get your supply. There may be some delay to nearby points, but it will not be serious.

We are now in the midst of this great grain movement, but we are supplying all the cars and engines necessary to handle it, and it is now coming forward from the Northwest

by thousands of cars. There is some congestion at intermediate and Atlantic ports, because of shortage of ocean vessels, but new vessels are coming from the shipyards daily, and these ships are being hastened by the prompt delivery of the iron and steel your plants are turning out, and it is moving without interruption, and on account chiefly of this co-operation.

You have heard of "Shipping days". What is this? To many of you not familiar with the details of your traffic affairs, it means that the administration has adopted certain days only when small shipments will be handled. This plan is working out without hardship to the consumer; in fact, it develops that he is able to get his goods even more promptly than under the old plan. This is conserving cars. I will not undertake to tell you how many thousands of car hours, car days and car miles it is saving to the administration railroads, and every car day and car hour and car mile saved is equal to that many new cars put into service. In this effort, we have found the hearty co-operation of a very great majority of shippers and I may say that all of the shippers of iron and steel products.

We have adopted also "direct routing". That is to say, sending your freight by the shortest route, instead of, as under the old competitive rule, by the longest route wasting as we did much of your and our time, labor, fuel and a serious delay to our cars and locomotives. Here, too, we save car and locomotive miles, hours and days running into the hundreds of thousands, and also a saving of man power. All this is being accomplished by, and with, your co-operation.

In the matter of iron ore traffic, to which I give personal attention, and we must first have iron ore before the metals in which you gentlemen deal can be produced, this year's production from the Lake Superior district will, by co-operation with your iron and steel committee, reach approximately 64,000,000 tons. Notwithstanding the great scarcity of labor at the mines and the very great quantity of low phosphorus and manganese ores, not easily produced, needed to produce the quality of iron so much needed in the manufacture of guns and ships, the shipping season will close with sufficient of

all kinds of ore to carry the furnaces and mills through the winter until we can again ship ore in 1919. Co-operation here with your allied interests, the mining companies, is working to our mutual benefit, as up to this time we are several million tons ahead of corresponding period last year.

The vessel interests, handled through the vessel committee and controlling upward of 400 vessels on the Great Lakes, has done its share in giving more prompt dispatch to the iron ore this year. All this could not have been done without co-operation, with the final result, that collectively, this country is going to furnish metals sufficient for all war munitions, for ship building, for guns and shells, and everything else to enable us to continue the great battles against the Huns, and which we are sure will very soon place us in possession of the great ore fields in and around Metz which they have so jealously guarded.

You gentlemen of the allied metals industry, with your great leaders, and we of the railroad administration, under the leadership of our director general, Mr. McAdoo, and his able lieutenants, co-operating with you as never before, and with our faithful allies, will by this co-operation produce only one result and that is ***victory***.

Report of the A. F. A. Committee on Foundry Costs

Since the annual meeting of your association held at Boston, Sept. 24 to 28, 1917, your committee has reviewed and approved the standard cost system, designed by C. E. Knoeppel & Co., New York. Copies are in the hands of all subscribers, much of the work with individual subscribers has been completed by our experts, and settlement made with our experts, all as appears herewith.

On Oct. 19, 1917, a meeting was held at the Cleveland Athletic club, Cleveland, and the preliminary report of C. E. Knoeppel & Co. was reviewed and all principles employed were approved with the exception of that covering the method to be used for the overhead on labor. It was arranged to defer a decision upon this point until a meeting to be held Oct. 29, 1917, at which time actual figures from the books of the concerns of some of your committee, compiled in the meantime, could be analyzed, and an intelligent decision made.

This meeting was attended by the following members of the cost committee: B. D. Fuller, H. J. Koch, J. Roy Tanner, C. H. Gale, and A. O. Backert. C. E. Knoeppel & Co. were represented by C. E. Knoeppel, W. A. McCall and several of the cost experts of this firm.

On Oct. 29, 1917, the meeting referred to was held at the William Penn Hotel, Pittsburgh, and the report of C. E. Knoeppel & Co. thoroughly reviewed and instructions issued to proceed with the preparation of the bulletins to be sent to subscribers. This meeting was attended by J. Roy Tanner, chairman; H. J. Koch, C. H. Gale, G. D. Piper, C. R. Messinger and B. D. Fuller. C. E. Knoeppel & Co. were represented by W. A. McCall and M. J. House.

On Dec. 21, 1917, a meeting was held at the William Penn hotel, Pittsburgh, and the text of the cost bulletins for subscribers was reviewed and finally approved.

At this meeting your committee unanimously adopted a resolution, in the interest of uniformity, recommending to your directors the opening of the list of subscribers to the cost fund to nonmembers.

This recommendation was subsequently accepted by your board of directors and the privileges of our cost system extended to nonmembers at a rate of $25 in excess of that charged to members.

This meeting was attended by J. Roy Tanner, chairman; C. H. Gale, G. D. Piper, H. J. Koch, B. D. Fuller and A. O. Backert. C. E. Knoeppel & Co. were represented by M. J. House.

In answer to a request for a report from C. E. Knoeppel & Co. concerning the status of their work to date, they say:

"We regret to advise that we have not made as much progress in respect to reports, owing to the fact that our stenographic department has been overloaded with work, a large proportion of which is for the United States government but hope for some help soon.

"Otherwise the American Foundrymen's association has been practically cleaned up, representatives having visited all plants except a few outside of the free limits who did not care to pay expenses, two recent subscribers and two or three in this vicinity who did not care for calls, but will receive them in due course at any rate.

"We have met with considerable indifference on the part of subscribers and have experienced much difficulty in many instances in obtaining information."

Your committee wishes to impress upon all members the fact that although the work of standardizing cost keeping methods has been completed, and is available, no benefits can possibly be realized by the foundry industry unless the uniform method is put into actual use. The system is designed to cover the needs of the most highly organized business, and can be simplified and condensed so as to fit a business of the most elementary character. The all important point is that whether complicated or simple, the business should be founded upon a cost system that is

uniform in principle with that of others, and an earnest plea is here made that notwithstanding the present pressure of war work, we keep in mind the after-war conditions which are bound to prevail. Then if we are wise we will be ready to meet those conditions, first by knowing our costs, and finally by knowing that our methods are the same as those of others and that when figures are made by different organizations, the factors entering into such figures are the same, having small local differences.

It is gratifying to be able to report that more members have taken advantage of the benefits of this cost work undertaken by the association and during the year ended Sept. 1, 1918, 15 additional names were added to the list of subscribers to this work. This brings a total number of subscribers down to date of 117 as compared with 102 on Sept. 1, a year ago. The total amount subscribed on Sept. 1, 1918, was $8211.25, as compared with $7246.25 on Sept. 1, 1917.

Of the $8211.25 subscribed for this work, $5488.70 had been paid into this fund on Sept. 1, 1918, leaving a balance due on subscriptions of $2722.55. The total disbursements from this fund amount to $3892.07, leaving a cash balance on hand, Sept. 1, 1918, of $1616.53.

Attached hereto is a list of subscribers to Sept. 1, 1918, together with a financial statement by the secretary-treasurer.

FINANCIAL REPORT

American Foundrymen's Association, Inc.

Special Cost-Keeping Fund

Sept. 1, 1918

RECEIPTS:		
Subscriptions	$5,488.70	
Bank interest	19.90	
Total receipts		$5,508.60

DISBURSEMENTS:

C. E. Knoeppel & Co. (On account)	$3,074.50	
American Foundrymen's Association (on account)	816.13	
Sundry expense	1.44	
Total disbursements		3,892.07
Bank balance, Sept. 1, 1918		$1,616.53

Total subscribers, Sept. 1, 1918	117
Total amount subscribed	$8,211.25

A complete list of subscribers to this fund on Sept. 1, 1918, follows:

Advance Foundry Co., Dayton, O.
Albany Foundry Co., Albany, N. Y.
Atlantic Radiator Co., Huntington, Pa.
Atlas Foundry Co., Detroit, Mich.
Barnes Foundry Co.
Beatty Bros., Ltd., Fergus, Ont., Canada.
Bessemer Foundry Co., Grove City, Pa.
Birmingham Iron Foundry, Derby, Conn.
Cadillac Machine Co., Cadillac, Mich.
Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Canada Machinery Corp., Galt, Ont., Canada.
Carr, Stuart R., & Co., Baltimore, Md.
Central Foundry Co., New York.
Central Oil & Gas Stove Co., Gardner, Mass.
Chicago Steel Foundry Co., Chicago.
Clearfield Machine Shops, Clearfield, Pa.
Clyde Iron Works, Duluth, Minn.
Columbia Malleable Iron Co., Columbia, Pa.
Cox, Abram, Stove Co., Philadelphia.
Cyclops Foundry Co., Pittsburgh.
Darling Pump & Mfg. Co., Ltd., Williamsport, Pa.
Dayton Castings Co., Dayton, O.
Deming Co., Salem, O.
Dennison Foundry & Machine Co., Dennison, O.
Dewey Bros. Inc., Goldsboro, N. C.
Dexter Folder Co., Pearl River, N. Y.
Diamond Iron Works, Minneapolis, Minn.
Dodge Mfg. Co., Ltd., Toronto, Ont., Canada.
Domestic Engine & Pump Co., Shippensburgh, Pa.

Douglas, W. & B., Middletown, Conn.
Driver-Harris Wire Co., Harrison, N. J.
Duquesne Steel Foundry Co., Pittsburgh.
Enterprise Foundry Co., Auburn, N. Y.
Fairmont Mining Machinery Co., Fairmont, W. Va.
Farquhar, A. B., Ltd., York, Pa.
Farrell-Cheek Steel Foundry Co., Sandusky, O.
Fate, J. D., Co., Plymouth, O.
Foster-Armstrong Co., East Rochester, N. Y.
Fort Pitt Steel Casting Co., McKeesport, Pa.
Franklin Machine Co., Providence, R. I.
Galt Malleable Iron Co., Ltd., Galt, Ont., Canada.
Galt Stove & Furnace Co., Ltd., Galt, Ont., Canada.
Girard Iron Works, Philadelphia.
Great Lakes Foundry Co., Port Huron, Mich.
Grey Iron Casting Co., Mt. Joy, Pa.
Griswold Mfg. Co., Erie, Pa.
Harrison Safety Boiler Works, Philadelphia.
Hershey Machine Co., Manheim, Pa.
Holland Furnace Co., Holland, Mich.
Holt Mfg. Co., Stockton, Cal.
Hunter, James, Machine Co., North Adams, Mass.
Indiana Foundry Co., Indiana, Pa.
Jencks Machine Co., Ltd., St. Catherines, Ont., Canada.
Joliette Steel Co., Ltd., Montreal, Que., Canada.
Joubert & Goslin Machine & Foundry Co., Birmingham, Ala.
La Compagnie Desjardins, Ltd., St. Andre de Kamouraska, Que., Canada.
Lake Erie Foundry Co., Buffalo, N. Y.
Lake Shore Engine Works, Marquette, Mich.
Lane Mfg. Co., Montpelier, Vt.
Lansing Foundry Co., Lansing, Mich.
Lawton, C. A., Co., De Pere, Wis.
Lincoln Iron Works, Rutland, Vt.
Locomotive Finished Material Co., Atchison, Kans.
Lombard Iron Works & Supply Co., Augusta, Ga.
Lundin Steel Casting Co., Neponset, Mass.
Lunkenheimer Co., Cincinnati.
Mahoning Foundry Co., Youngstown, Ohio.
McAvity, T., & Sons, Ltd., St. John, N. B., Canada.
McDougall Co., R., Ltd., Galt, Ont., Canada.
Mac Kinnon Boiler & Machine Co., Bay City, Mich.
Michigan Steel Castings Co., Detroit.
Milford Iron Co., Milford, Mass.
Milwaukee Steel Foundry Co., Milwaukee, Wis.

Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Monarch Foundry Co., Detroit.
Muncie Foundry & Machine Co., Muncie, Ind.
Murray Iron Works Co., Burlington, Iowa.
Newark Stamping & Foundry Co., Newark, Ohio.
Nordberg Mfg. Co., Milwaukee, Wis.
Novo Engine Co., Lansing, Mich.
Ohio Steel Foundry Co., Springfield, Ohio.
Pangborn Corp., Hagerstown, Md.
Pelton Steel Co., Milwaukee, Wis.
Phoenix Iron Co., Meadville, Pa.
Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
Read Machinery Co., York, Pa.
Ripley Foundry & Machine Co., Ripley, O.
Riverside Steel Casting Co., Newark, N. J.
Rosedale Foundry & Machine Co., Pittsburgh.
Rothe, Jos. F., Foundry Co., Green Bay, Wis.
Roots, P. H. & F. M., Co., Connersville, Ind.
Simplex Automobile Co., New Brunswick, N. J.
Simpson Foundry Co., Newark, O.
Sivyer Steel Casting Co., Milwaukee, Wis.
Skagit Steel & Iron Works, Sedro-Wooley, Wash.
Smidth-Lewis Foundry Co., New York City.
Smith, A. P., Mfg. Co., East Orange, N. J.
Smith's Falls Malleable Castings Co., Ltd., Smith's Falls, Ont., Canada.
Standard Malleable Iron Co., Muskegon, Mich.
Star Drilling Machine Co., Akron, O.
Superior Steel Castings Co., Benton Harbor, Mich.
Sweet & Doyle Foundry & Machine Co., Green Island, N. Y.
Swett, A. L., Iron Works, Medina, N. Y.
Taylor-Forbes Co., Ltd., Guelph, Ont., Canada.
Taylor Wilson Mfg. Co., McKees Rocks, Pa.
Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
Treadwell Engineering Co., Easton, Pa.
Trout, H. G., Co., Buffalo, N. Y.
Walker Foundry Co., Erie, Pa.
Waterous Engine Works Co., Ltd., Brantford, Ont., Canada.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
West Steel Castings Co., Cleveland.
White, J. S., Co., Pawtucket, R. I.
Patrick White Sons, Perth Amboy, N. J.

Whiting Foundry Equipment Co., Harvey, Ill.
Williamson, J. E., Co., Bellewood, Pa.
Youngstown Sheet & Tube Co., Youngstown, O.

Respectfully submitted,

J. Roy Tanner, *Chairman,* Pittsburgh Valve, Foundry & Construction Co.
C. R. Messinger, Sivyer Steel Casting Co., Milwaukee.
H. J. Koch, Fort Pitt Steel Casting Co., McKeesport, Pa.
C. H. Gale, Pressed Steel Car Co., McKees Rocks, Pa.
A. O. Backert, *Secretary,* Cleveland.

Discussion

Dr. Robert Grimshaw.—Mr. Chairman and members, there has been some complaint about the delay in the delivery of these 117 reports. A certain lawyer was asked why his client did not appear in court. He said, "There are 26 different reasons. In the first place he is dead." Now, I can give you 26 different reasons why these reports have not been all delivered, and two of them are just as valid as the one I have quoted. First, the Knoeppel company has been shot up by enlistment, by the draft, and by government priority; but, in the second place, those of us who went around endeavoring to see people who should install this standard system, were met with ignorance and opposition.

One man whom we visited said he did not know what his metal cost him, and did not care a darn. Now, what are you going to do with people of that kind? One firm has not yet got its report. But when I went there, the head of the concern had just gone down to Washington to see if he could not get them to take the plant in half payment of the taxes and I could get no data. So, of course, he has not yet had his report.

I will take the few minutes that have been assigned to me by referring to some of the plants here on the list. I

found one or two establishments that had admirable cost systems; but, as a rule, sometimes when they gave the cost in the fourth decimal place, the whole number was wrong. I found an order of one manifold of 30 pounds weight, sold for six cents a pound. It cost 10½ cents to make.

I found more than one establishment that had a flat price. And I wish to say that those that have a flat price are skating on very thin ice. I asked in one such establishment if they had contracts with their customers to deliver all their castings, and they said "no." Then I said, "you are stuck. You are getting the hard ones, and somebody else will get the easy ones. But even supposing you have a contract to furnish all the castings for some concern, you cannot guarantee that that concern's sales will run the same, and it may have more hard ones the second month than the first."

I found one concern that started some 12 or 15 years ago with a small capital, 70 per cent of it being wind, namely, good will; and another 8 per cent was water, namely, patents. That concern made $26,000 in one month, and did not care what castings cost it at present. The system of bookkeeping there was of this character: They had partners' salaries, stenographers' salaries, direct and indirect labor, and lawyers' fees, all under the head of "wages." As regards their depreciation account, they bought a block of nine acres of land for $1000, and in two years sold off fire-brick clay from it. At that time the value of the property next door advanced to $4000 an acre. But this concern charged 2 per cent depreciation on that land, because it had sold off the fire clay. That is one sort of depreciation accounting.

Another concern charged 2 per cent off on its foundry. It had a concrete foundation and corrugated iron over that, and charged off 2 per cent on that building, because it had read somewhere that every "concrete and iron" building should be charged off at 2 per cent; whereas 10 per cent would have been quite decent for that particular plant.

I found one concern where the cost accountant was a young girl—it was a big concern—who was charged with all the correspondence, with the bookkeeping, with answering the telephones, and everything of that kind. The heat sheet was

made out on the back of envelopes. Now, you can imagine what the cost accounting there would be.

I found a concern that is nationally—perhaps almost internationally—known, for the excellence of its product. It has its own foundry and a very large machine shop. There was no "general expense" added to the foundry. I asked why, and the auditor said he did not want to. There is no use in arguing with people of that kind; but those people may be skating on very thin ice, and the time may come when those who are now coining money will be skinning pennies.

I found the general custom to be to charge almost anything that they did not know what to do with into "General Expense." I found "shipping and crating" charged to cleaning department. I found establishments that were using part of their own product, and selling the rest, charging shipping and crating expense to "General." As a matter of fact, some of the castings there went out charged 1½ times for shipping and crating.

Now, all along the line I found this same condition, and at the same time a sense of security, where people are satisfied that they are making money. There was no question about that; but they were making fool bids, particularly in the matter of flat price.

Of course, there is a great deal of trouble, purely technical; and, being an engineer, I was able to give advice, in a good many places, that a cost accountant perhaps would not be able to do. I found, however, that the charges were absolutely incorrect. They were charging materials at the invoice prices and sometimes only adding freight, and did not take into consideration the cost of handling. One foundry handled its coke five times, which broke about 10 per cent, and there was no charge whatever for that labor.

I found one establishment which got an order to pour 30-pound hubs into 20,000 three-foot tractor wheels that were delivered to them, and each 3-foot wheel took a 4-foot flask to do it, and they got the same price for that, the same as if it were poured in a 28 x 28 flask. Take the expense of cutting all that sand and ramming it up, and the cost of transporting

that heavy flask and its contents, yet they got the same price for that 30 pounds as if the hubs were molded alone.

Now, in the 37 different places I visited I did not find six that had a decent cost system. I found two that had an excellent cost system, but, incidentally, had the worst foundries. One concern had to send an engine and flat car and two men an eighth of a mile for the large flasks, and it cost $30 to bring one flask to the foundry.

I found another where they had flasks and patterns for nearly the last 50 years, because once in five or six years there would come an order from Mexico for an extra part. If the foreman of that foundry was hit by an automobile, they would have to go out of business, because nobody else could find those flasks. Such a condition is a dangerous one for the foundries of this country.

They are now making money hand over fist—there is no question about it. But the time is coming, after this war, when things will have to be done differently. I say this advisedly, because our wages are getting up to such a point that we will be unable, after the war, to sell outside of our own country, unless we reduce our costs, and know what they are.

I happened to be in Germany until December, 1914, and know that in the second month of the war that country had arranged to have her cripples and blind taught new trades, and provided for marketing their products. They expected the war to last only six weeks. The only trouble in their calculations is that they got the decimal point placed wrong.

We will have to do two or three things; in the first place, call in competent engineers and do away with old-fashioned ways. I found the same methods in use now that were used when I was a boy.

Incidentally, I will state, in concluding, that my first experience with a foundry cost system was in the year 1873, when we ordered a great many brass castings, and the method of charging was simplicity itself. The castings always cost the market price of copper, plus five cents. That was the cost system of 1873.

MR. A. O. BACKERT.—As a matter of fact, probably 90 per cent of the foundrymen in the United States do not know what their castings are costing them. They are selling castings that cost them 5 cents a pound for 10 cents, and castings that cost them 10 cents for 5 cents. They hope to be able to get by that way.

However, 117 foundries in the United States have already adopted the standard cost system. The total amount subscribed on Sept. 1, 1918, was $8,211.25, of which $5,488.70 has been paid into this fund, leaving a balance due on subscriptions of $2,722.55.

The total disbursements from this fund amount to $3,892.07, leaving a cash balance on hand, Sept. 1, 1918, of $1,616.53.

I want to say in this connection that the American Foundrymen's association offers foundrymen an opportunity to install a high grade cost system at a nominal price. If a foundryman attempted to go out and install a cost system, and hired an expert, it is doubtful whether he would get as good a cost system as the standard system adopted by our organization, and it probably would cost him from $1000 to $5000, whereas the maximum charge for this system is $250 for the largest foundries.

Selecting Sand-Blast Equipment for the Foundry

By H. D. Gates, Hagerstown, Md.

The history of the last decade or two has recorded no more striking example of ability to stand up under adverse conditions than that displayed by the foundry industry. No surprise, therefore, is occasioned by the industry's whole-hearted response to the nation's cry for manpower, threatening though, as it does, its very existence. As this demand becomes more insistent in the future the use of every dependable device that will release labor becomes a patriotic duty. Fortunately some devices make this duty a profitable venture and none more so than an efficient sand-blast.

Any discussion of sand-blast equipment must recognize that probably no other class of men are as familiar with its operation as the foundrymen, for it was in the foundry that the sand-blast found its first broad and general application.

It is said that familiarity breeds contempt and it may be on this premise that the foundryman approaches the selection of sand-blast equipment with less assurance of attaining desired results than men in other lines of business. The economy and advantages to foundry operation resulting from an efficient, well planned system are so firmly established that no reiteration of them is necessary on this occasion. Any doubt of this is refuted by the constantly increasing number of sand-blast installations—installations too that run into tens of thousands of dollars where a decade ago a thousand dollars seemed a big sum to spend for equipment of this kind.

Your interest today is in either the selection of satisfactory new equipment or the economical operation of apparatus already installed, and an analysis of the factors bearing on this problem should prove of interest and value. Failure to accomplish either or both of these results may nine times out of ten be

charged to the foundryman himself, but this is rarely acknowledged, and without investigation or reason inability to secure results is at once charged to the sand-blast equipment. This is bound to continue until the purchaser approaches the subject from a different angle and attitude than at present.

Some Fundamental Considerations

In your consideration of the subject shape your investigations first to an intelligent understanding of what an efficiently planned system will accomplish and save for you. Forget the

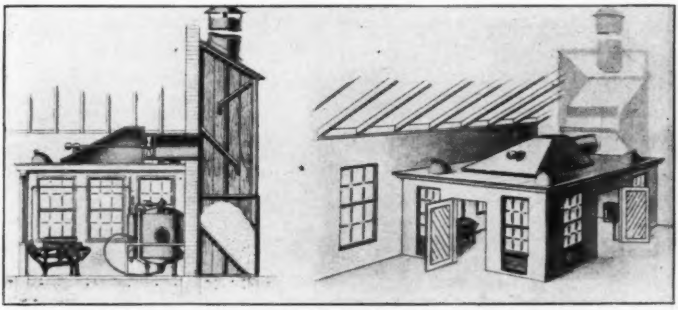


FIG. 1—AN INEXPENSIVE SAND-BLAST ROOM INSTALLATION

purchase price until your requirements have been fully determined and met, by a system laid out and designed to secure the minimum cost of cleaning. Unless this result is attained your installation will be an expense instead of an investment. On the other hand if this result is realized I believe you will get a greater return from the sand-blast than from any other equipment in your foundry. Let the purchase price be your last consideration, for with other factors clearly defined, it is easy to determine whether the results to be obtained warrant the expenditure proposed.

Remember too that purchase price is a one-time expenditure—operating cost is continual, and a small saving per ton in cleaning cost will soon return the cost of the equipment. It represents just the difference between a gain and a loss.

Every foundry has conditions and operations peculiar to itself. Your installation should be an entirely individual prob-

lem—but you make it far from such when you write for "catalog, prices and delivery" on sand-blast equipment; and may be surely inviting disaster. If you are to get results, which is the final test of the *cost* of a sand-blast system, what you want is not "catalog and prices"—not even a "salesman"—but experienced counsel trained in sand-blast engineering and practice, and by no means less important, whole-hearted co-operation from your own organization.

Such counsel is at your command if you go to the right source and in the right attitude. While you may have men in your organization who have had years of experience in the use of sand-blast, don't anticipate that this familiarity with one, two or even a half dozen installations can equal the knowledge and experience of men who make this their daily business as you make the production of castings yours and who are constantly visiting and studying the installation and operation of hundreds of systems. It is this knowledge and experience that

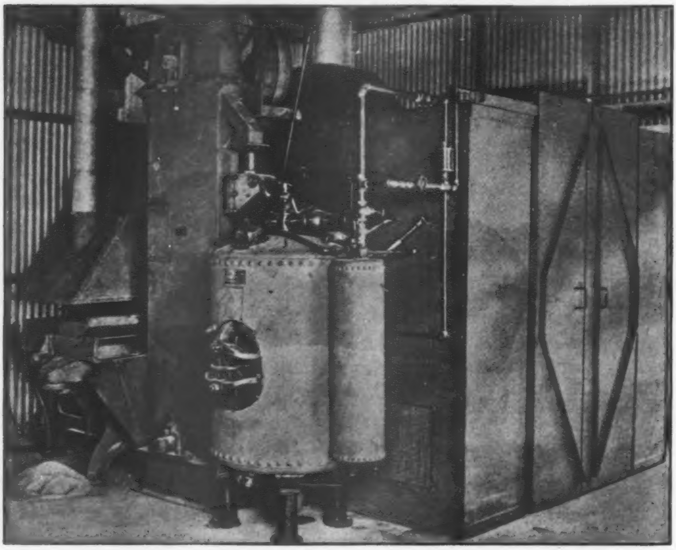


FIG. 2—STEEL-PLATE SAND-BLAST ROOM WITH PRESSURE MACHINE

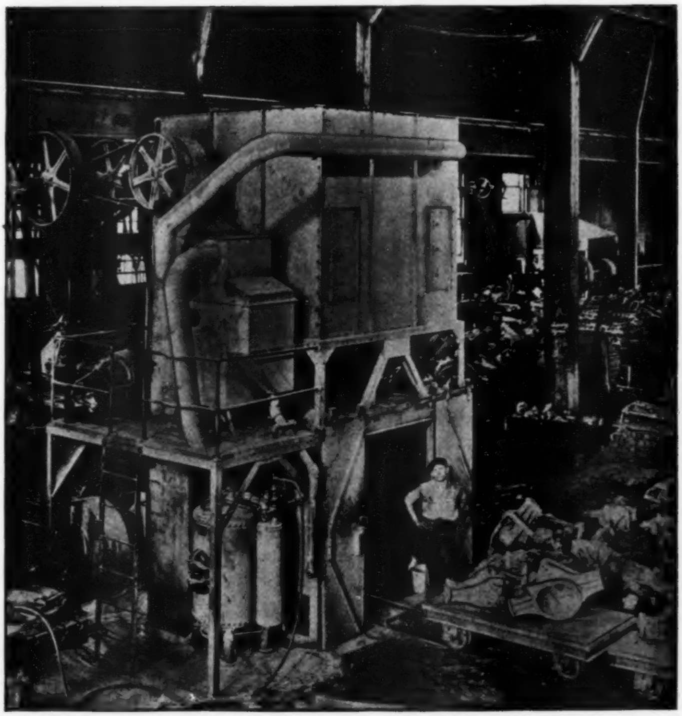


FIG. 3—SAND-BLAST ROOM WITH SAND SEPARATING AND ELEVATING SYSTEM

you should seek and profit by, so shape your attitude and efforts to secure it as applied to your own problem.

What Happened to the Engineer

A recent incident in this connection will illustrate. One of the largest industries in its line in the United States producing war material sent out over the signature of its purchasing agent a so-called specification for a sand-blast installation asking "prices and delivery by return mail". The specification as written showed such lack of adaptability to stated requirements

that an engineer was immediately sent to ascertain existing conditions. Let us quote the engineer's report:

> "I shall never forget Mr. Purchasing Agent. We seriously wounded his pride by hinting that his letter was not entirely sufficient to give an intelligent bid on his requirements. His response to my introduction was, 'We are extremely busy here and perhaps your time is also limited—you have wasted valuable time calling here that could have been used preparing data that would have been of service to us. Good bye!' "

A proposal was made on this so-called specification; it figured in the neighborhood of $20,000. Later another department asked an engineer to call and go over the plans. A four-hour conference developed conditions that entirely eliminated the original specification and the substitution of a plan suggested by the sand-blast engineer, with a saving of over $6000 in the initial cost. Who was the sufferer, and whose was the loss of six weeks of "valuable time"? Certainly not the manufacturer.

Obviously in the installation of sand-blast equipment you must turn to the manufacturer. His qualifications to give you the service desired must include: Long and varied practical experience; an organization for the design, manufacture and installation of sand-blast equipment; physical and financial facilities for production; and, for your benefit above all, a line so complete as to permit of absolutely unbiased counsel in suggesting equipment. Ask to have a representative visit you and make this by appointment. Provide ample opportunity for the observation of conditions and operation. Provide for conference with the men of your own organization who will be the deciding factors. Discuss the subject fully and thoroughly until your minds are met on what is needed. With the plans and suggestions prepared, go over them again with the sand-blast engineer until you are entirely conversant with and fully understand the plan—the operation of the installation and the results to be obtained. Two or three conferences along these lines will save you time, give a more intelligent understanding than is possible by proxy or correspondence and secure for you an investment that will pay a constant and handsome return. Put this all up to

your operating department heads. Keep it away from the purchasing end for by training they can't see beyond the invoice figure—and your money is not made there, but many times the invoice price may be lost. You must measure the price of your sand-blast installation by the cleaning cost per ton and if you do this measuring intelligently results will be all you can desire.

Many Sizes and Types

The advantage, to say nothing of necessity, of such thorough consideration will be apparent when it is understood that one manufacturer alone standardizes over 20 different types and sizes of sand-blast machines, exclusive of innumerable designs

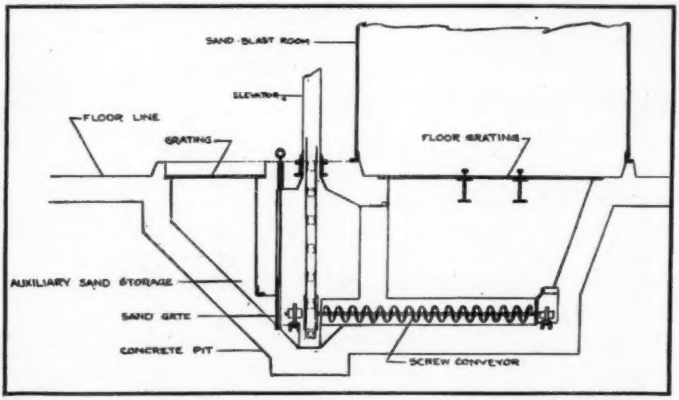


FIG. 4—SECTION THROUGH FOUNDATION OF SAND-BLAST ROOM

that are constantly being produced to meet special requirements. Some understanding of the underlying principles, functions and operation of various types of sand-blast machines and installations will be of aid and it will be my endeavor to cover these as fully as is possible in a limited discussion of this kind.

Basically sand-blast machines will divide into four general groups as follows: Hose machines; cabinets; barrels; and tables. The method of operation may be by either the direct pressure, the suction (syphon) or the gravity systems.

In direct pressure systems the sand is under pressure in a sealed container, sand and air being discharged in combination

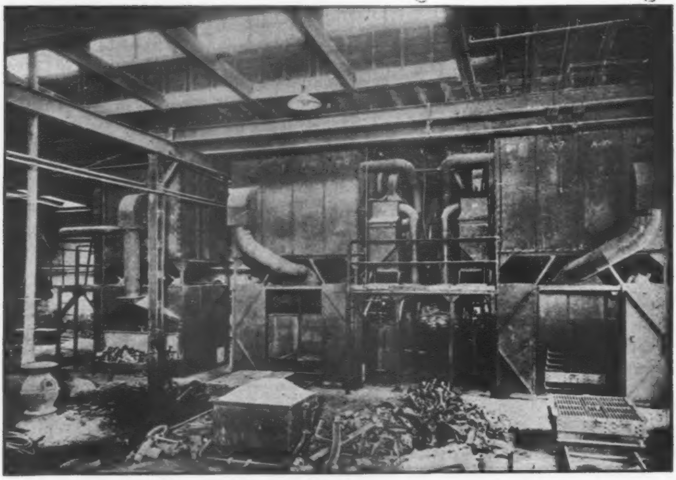


FIG. 5—SAND-BLAST ROOM INSTALLATIONS EQUIPPED WITH TABLE AND CARS FOR HANDLING WORK

without expansion through a hose nozzle giving the greatest velocity and highest efficiency possible. The majority of hose machines are of the direct pressure type, indeed, the first application of sand-blasting was the hose machine type and it is still used without exception in sand-blast room installations. It offers a range of application that is possible with no other type. For a line and character of work that is varied and of medium volume it undoubtedly represents the most satisfactory equipment. Where the tonnage is large and the pieces are of a weight and size too great for convenient handling it is indispensable. The use of the hose machine demands some enclosure and experience has shown the wisdom and economy of a well ventilated and well lighted room for the purpose.

Sand-Blast Rooms

While the cleaning cost will always be reduced by mechanical methods of handling the work and the abrasive for reuse, a very convenient room can be provided with small outlay and may be built of rough lumber as shown in Fig. 1, with an exhaust fan in the ceiling or wall, carrying the dust-laden

air into a settling box or chamber that will retain the heavier particles, the lighter material being carried off into the atmosphere.

The inclusion of mechanical handling and screening of the abrasive makes a steel room most advantageous and economical. The simplest of these provides for the location of the sand-blast outside the room which is left free for the blasting operation, with controls extended inside to within easy reach of the operator, as illustrated in Fig. 2. A mechanical separator, driven by a powerful air motor, at one operation removes both fine and coarse material. The clean, sharp abrasive for reuse is delivered by an elevator to a sand storage bin above the sand-blast machine for refilling. In this type of room the spent abrasive is shoveled from the floor to a chute in the side of the room connected to the separator.

FIG. 6—REVOLVING TABLE CABINET TYPE OF SAND-BLAST APPARATUS

As the daily tonnage rises, the capacity of the sand-blast installation expands, and without added cost for labor, in proportion as appliances are added for the mechanical handling of the abrasive, and the work is properly handled and routed. The problem of handling the abrasive can be met by a grated floor in the room through which the spent abrasive falls to a conveyor below which carries it to the elevator boot. Built into the elevator system should be an efficient separating system, preferably a combination of mechanically operated screens, with an exhaust to remove the fine material. Thus both the coarse material that will not pass the nozzle and the disintegrated abrasive, core sand and all fine stuff without abrasive qualities are removed. This is shown in Fig. 3.

The clean, sharp abrasive passes to a storage bin for refilling the machine, which is controlled from within the room. The waste material is carried to a waste bin with the outlet at convenient points. An auxiliary sand-storage bin, a part of the foundation, loads through a grated opening outside the room, and carries several days' supply of abrasive, which is fed to the system through a gate as renewal is required. See Fig. 4. This continuous operation may also be accomplished by placing the sand-blast machine itself in a pit beneath the grated floor, but the depth required for properly proportioned hopper to accommodate the entire floor area and the separating system results in a depth of pit and foundation that while showing no economy in cost even by the elimination of the conveyor and elevator, is frequently impracticable due to water conditions and also it makes impossible the advantage of the auxiliary sand-storage for handling the abrasive in volume. Where floor area is, however, at a premium this system may be found advantageous.

Light and Ventilation Necessary

Light and ventilation are of course necessary to adequately handle any considerable volume of work. Electric light fixtures with parabolic porcelain enameled reflectors will properly diffuse light equally to all points, and if fitted with

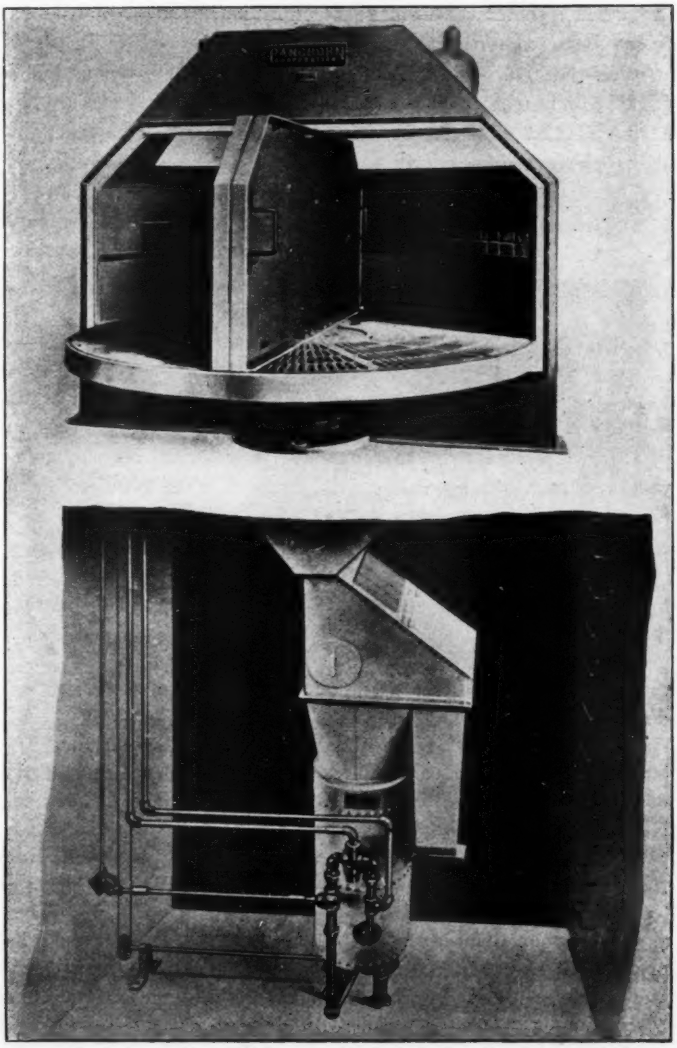


FIG. 7—CABINET TYPE MACHINE WITH PIT FOR RETURNING ABRASIVE TO MACHINE BY GRAVITY

protective fronts a perfect protection is afforded the lamps from flying abrasive.

Ventilation which should be ample will of course be governed by the requirements of the work in hand. No hard and fast rule can be suggested for this, but a constant change of air is required and this should be a minimum of say four to six changes per minute for the general run of brass and malleable castings, six to eight changes for cast iron and 10 changes for steel. A slow-speed exhauster of low horsepower requirements is most satisfactory as well as most economical.

Some diversity of opinion is expressed as to the most satisfactory system for removing the dust-laden air. Theoretically it is desirable to keep the dust in transit below the operator's head, and this theory creates some adherents for the down-draft system whereby the dust-laden air is drawn downward through the grated floor. Failure in practice to keep the gratings clear, however, seriously retards circulation and experience has demonstrated that more positive results are obtained from an up-draft, where there can be no interruption to the draft, and generally better operating conditions secured. As the dust is created where the blasting operation takes place, well above the floor line, and with a general tendency to rise, the up-draft system removes it without change of direction.

In considering claims for conditions provided within sandblast rooms common sense tells us the dust is there and no improvement is possible over its removal as fast as created. Not only is this rapidity of removal essential from the standpoint of hygiene and sanitation, but equally so to provide for clear vision for efficiency in cleaning. Obviously protection for the operator from the dust-laden air and the flying abrasive other than afforded by the exhaust system must be provided. The most satisfactory device is a dust-proof ventilated helmet. Air is introduced into the helmet from the compressed air line, to which the helmet is connected by a small flexible hose, weighted over pulleys to take up slack in any position and permit ease of movement to the operator.

The dust may be collected by various devices or entirely confined by a cloth screen dust arrester, if it is created in such volume as to be not only an annoyance to shop or neighborhood, and this confinement is a matter of economy as the cleaned air after passing through the

FIG. 8—SUCTION TYPE OF SAND-BLAST BARREL

arrester can be returned to the room or to shop ventilating system, a feature of considerable importance in winter weather.

Handling Systems for Sand-Blast Rooms

The rooms, of such size and arrangement as individual requirements dictate, should be equipped as the product demands with a track for cars with grated tops on which the work can be blasted as well as transported without other handling, or where a monorail system is used, this can be carried into the room and the pieces cleaned while suspended. Where the material is all or partly in the nature of bench work a rotative table installed in one side of the room is a decided advantage.

Some foundries having sufficient tonnage of both large and medium work have obtained a reduced cleaning cost by

installing a battery of two or more rooms, equipping each as the proportions of the work demand with car or table, as shown in Fig. 5.

The rotative tables are up to 90 inches in diameter and have a high partition across the center that completely closes the aperture in the room structure. The material to be cleaned is loaded onto the exposed half of the table, outside the room, by common labor; the table travels on ball bearings and is turned by the sand-blast operator to expose the cleaned work for unloading and to bring new work into the room for cleaning.

The entire time of the sand-blast operator should be devoted to the cleaning operation only. The handling of the work to and from the room should be done by other help. Frequently two operators are worked in a shift. While one is sand-blasting the other is delivering cleaned work and bringing up the new material for cleaning. Each thus handles and cleans his own work, which, in addition to giving continuous operation of the sand-blast, provides a periodical change of occupation.

Where the work is of a character requiring room cleaning and still all within the range of sizes to admit of cleaning on the rotative table, probably the hygienic table cabinet, Fig. 6, offers advantages found in no other type of installation. A semicircular cone-top steel cabinet fits closely to half the circumference of the table, the upright partition across the center of the table entirely closing the rear of the cabinet leaving half the table exposed. In the front of the upright wall of the cabinet and extending the entire length is an opening covered by a flexible sectional rubber curtain that retains the abrasive within the enclosure and through which the hose nozzle from a direct-pressure blast is directed onto the work to be cleaned. Unobstructed view of the work and interior of the cabinet is provided through a screen covered opening in the cone. Electric light fixtures provide satisfactory illumination within the cabinet.

The work is handled as with the room table. This device offers all the efficiency of a room installation for work within its limits, with the added advantages that the operator works in the open, without contact with dust-laden air as in the room,

no protection being required other than that afforded by the cabinet itself. The cabinet having less cubical contents than a room, the smaller ventilating system required helps to keep down the first cost of the installation. As with room installations, the sand-blast machine can be located on the floor level with elevator and separator for continuous operation, or

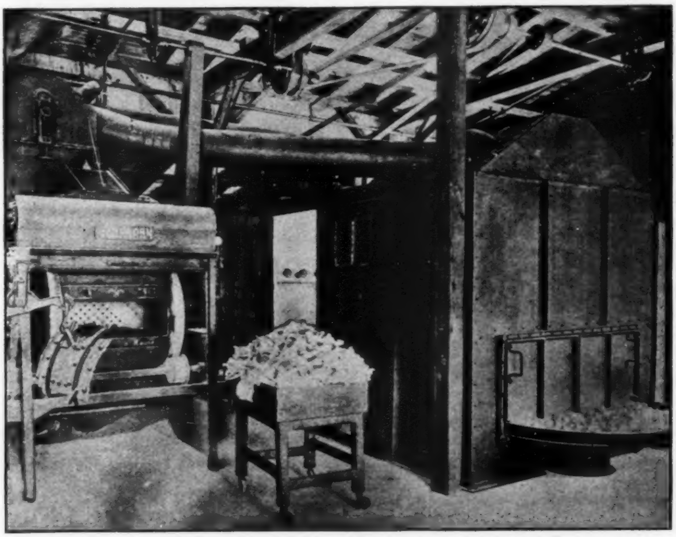


FIG. 9—COMBINATION ROOM AND BARREL INSTALLATION

a pit below the cabinet can be provided for returning the abrasive to the machine by gravity, as shown in Fig. 7.

Equipment for Sand-Blasting Small Castings

The conditions and equipment considered in the foregoing deal only with large work, but no less essential is the handling of small and light work of both the big foundry and the plant that devotes its production to work that is not adapted to handling in the room sand-blast. As the size of the work decreases, the efficiency and likewise economy of the hose sand-blast diminishes and more economical devices according to the

quantities and character of the pieces are found in cabinets, barrels and automatic revolving tables. Each of these are distinct in their inherent characteristics of design, operation and application.

The barrels and automatic tables are capable of handling the entire output of the small or medium-sized foundry within the limits of their capacities, and all of them are profitable in combination with a room installation to the large foundry with a varied line of work.

The cabinet sand-blast, a self-contained unit ready for instant use when attached to the air line, is essentially an auxiliary in foundry sand-blasting. The blasting operation is of the suction or syphon type. The abrasive is brought to the nozzle by a partial vacuum created by a jet of compressed air. The air and abrasive are discharged in combination through the sand nozzle, which, being of greater diameter than the air jet, admits of expansion with correspondingly decreased velocity, so that while the blasting efficiency with equal gage pressures is below that of the direct-pressure type, it is a most satisfactory device for special or precision work not economically handled by a large installation.

The floor of the cabinet being perforated, the spent abrasive flows back to the feed box, giving a continuously operating machine. Electric light fixtures are provided making it available for use either with natural or artificial light and openings are provided also for connections to the exhaust system. A choice of several types and sizes meets varying requirements.

The Sand-Blast Tumbling Barrel

For small work in any considerable amount, however, and particularly where no detriment to the pieces would result from the slow rolling process, no device shows the speed and economy of the barrel sand-blast. While the first adaptation of this system, consisting of placing the nozzle of the hose sand-blast in the ends of a revolving barrel, is still seen in some types, refinements have brought the barrel sand-blast a secure position of its own, which up to this time no other device has successfully challenged. There are different types of barrels and selection should be made with reference to the character of the work

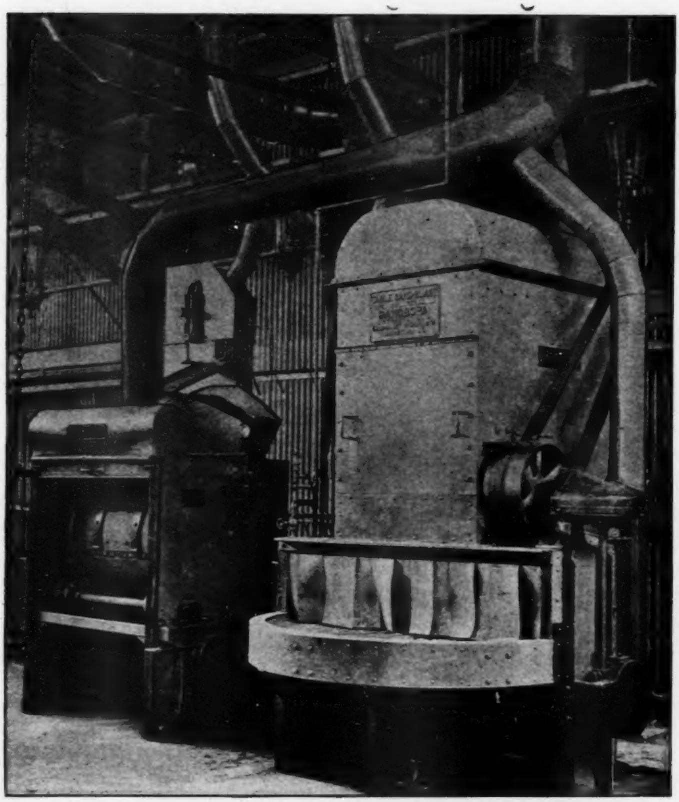


FIG. 10—AUTOMATIC REVOLVING TABLE SAND-BLAST MACHINE

to be cleaned, both as to size, shape and degree to which the sand is burned to the casting.

For small brass and malleable work that has been cleaned before annealing, the suction type, Fig. 8, will be found entirely efficient and has the advantage of a single self-contained unit with lower first cost. Three or four nozzles according to size cover the entire length of the drum and in the highest developed types the nozzles are adjustable as to direction to different characters of work that vary in their "riding" position within

the drum. This construction, too, permits the elimination of projecting nozzles that may catch and damage the work or the machine, as well as offering an in-swinging door that allows removal of the load by dumping without raking or other handling.

Large castings of either brass, iron or steel demand a heavier design and construction, and the combination of such a barrel with a room installation will take care of a very considerable output of varied work. Such an installation is shown in Fig. 9. The blasting action is of the gravity type, the abrasive being delivered to the nozzles by mechanical action and gravity; no portion of the force of the air is expended in raising the abrasive, and as the ratio of the air jet to the sand nozzle is greater than in the suction system, less expansion of the air takes place with proportionately increased blasting efficiency. The nozzles are located in each end of the drum, leaving the interior entirely unobstructed so that the size of pieces that can be cleaned is limited only by the dimensions of the door opening. The abrasive passes through perforations in the drum and falls into a hopper that conveys it to the elevator boot. As it is delivered from the elevator, a strong exhaust removes the fine light material, and vibrating screens reject everything that will not readily pass the nozzle, giving a continuous flow of evenly graded, clean, sharp abrasive. For the foundry whose product is of a size and character that will admit entirely of barrel cleaning, I believe there is no one other device that is as economical and satisfactory.

Automatic Revolving Table Sand-Blast

There are classes of work that by reason of shape do not adapt them to barrel cleaning. This includes precision work or pieces that are so light and fragile as to not admit of this method of sand-blasting, and are yet too small for individual cleaning to advantage with the hose machine in room installation. For this character of output the automatic revolving table sand-blast, Fig. 10, has found high favor. A grated-top table half exposed and half housed revolves at a slow speed. Within the housed portion a series of nozzles, fed from a direct high-pressure hose blast, are oscillated in adjustment with the

varying peripheral speeds of the table so that all points are brought with equal duration within the path of the blast stream. The pieces to be cleaned are placed on the exposed portion of the table as it revolves; they are turned as required and removed when cleaned. A flexible sectional rubber curtain permits passage of the pieces to and from the housing while retaining the abrasive within the enclosure and protecting the

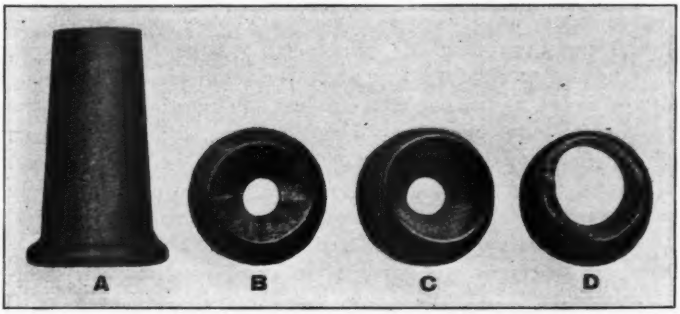


FIG. 11—NOZZLE WEAR HAS A GREAT EFFECT ON AIR CONSUMPTION
The nozzle should retain the original inlet size as it wears as shown at *C*

operator from dust and flying particles. An elevator and separator, as in the barrel, provide for cleaning and feeding the abrasive, making a continuous feed, self-contained unit. The installation of barrel and table together is frequently found advantageous.

Provision in all of these devices is also made for connection to the exhaust system, and it may be noted in passing that exhaust for the cabinet, barrel or table, or all in combination, with grinders as well where desired, can be connected to the exhauster-arrester system of the room installation.

Choice of Abrasives

The more modern types of any of the devices described are equally adaptable without change, by slight adjustment, to use of either sand or the metal abrasives. With the constantly increasing use of the sand-blast the question of the most satisfactory abrasive is naturally being given more attention. Like

pressures, no hard and fast rule can be laid down, but each problem must be solved by existing conditions, requirements and if need be, by experiment. Each producer of abrasive claims advantages for his product and there is no question but what each has advantages peculiar to itself.

The metal abrasives have many times the life of sand, do not require large storage capacity and create less dust in use. Their comparatively high initial cost demands careful reclaiming methods, as any considerable daily loss soon wipes out the saving their long life affords. To some lines of work they do not successfully lend themselves without after-cleaning of the pieces, as the fine metallic dust adhering by force of the blast creates defects in galvanizing, plating, etc. Moisture in the air lines too, is a decided deterrent to the use of metal abrasives, due not only to the fact that they do not flow freely when damp, but may readily rust into a solid mass.

Of the various sands offered silica and ocean sands only have the sharpness and hardness to make a satisfactory sand-blast abrasive. At the same, or even an advanced cost, undoubtedly the silica sands would have a general preference. Owing to the restricted areas of production, however, freight rates operate against their use at any considerable distance from the source of supply. It is only by a trial of each that an intelligent selection of available sands can be made, and some initial expense in comparative tests of all the various sands and metal abrasives will undoubtedly be fully returned in satisfactory results and economy of sand blast operation. Highest blasting efficiency from any abrasive, however, may only be anticipated when it is evenly graded, dry and free from loam and dust.

Tracing Operating Troubles

Operating troubles may usually be traced to three general causes, air pressure, moisture and abrasive. An installation that fails to provide for adequate control and regulation of these can hardly be called complete or expected to give maximum results.

All other factors being normal, air pressure governs results. When it is remembered that results at 20 pounds pressure are

but half that at 56 pounds; at 30 pounds half that at 64 pounds, and at 40 pounds half that at 72 pounds, it is seen that the increase in output and saving in labor will demand the maximum pressure that the character of the work will permit. Obviously soft brass will not stand the pressure required for cleaning steel, nor will the molding sand fuse and burn to the castings as to demand it.

Air volume should be ample and the flow steady. Air means horsepower, which in turn costs money, and the air volume should be restricted to the minimum to obtain the required results. As the flow of air increases four-fold with increases in the diameter of the nozzle, restriction at this point is most essential. It means not only a constant saving in operating cost, but in the case of limited air supply, increased air flow may cause a drop in pressure with a corresponding reduction of output.

This feature cannot have too careful attention. For example, a new nozzle with ¼-inch diameter opening, *A* and *B*, Fig. 11, flows, at 80 pounds pressure, 85 cubic feet of free air per minute. If the nozzle enlarges with use, *D*, Fig. 11, an increase of 1/64-inch increases the air flow by 12.5 per cent. With a 1/32-inch increase in diameter the air flow increase is 27 per cent and by a 1/16-inch increase in diameter the air flow has increased 56.5 per cent. The nozzle should retain the original inlet size as it wears at the discharge end, as shown at *C*, Fig. 11. Not only economy dictates this but it permits of predetermined air and horsepower requirements.

It is rather past conception that anyone would permit water to get into the gasoline tank of his automobile. The results would be disastrous, but how many are making provision to eliminate the water from their compressed air lines? In many cases, the air passes the "moisture" stage, and trouble is immediately experienced.

Moisture is detrimental to all air-operated tools and as it is variable with weather conditions some provision for its elimination before delivery to the sand-blast or to other tools is the truest economy. Various devices are produced for this purpose and where the moisture volume is not abnormal a simple separator, consisting of a tank fitted with a series of solid and

perforated plates placed at a slight angle from the horizontal is effective. The air supply pipe is carried to the bottom of the tank and capped, the air being released through tiny perforations aggregating the area of the pipe diameter. From the bottom of the tank it passes through the openings in the per-

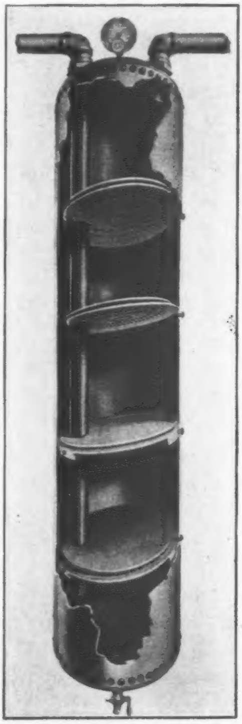


FIG. 12—SEPARATOR FOR ELIMINATING MOISTURE FROM AIR

forated plates striking the solid plates and passing around the outside to the next series, this operation being repeated several times until finally it reaches the top of the separator and flows through the outlet to the sand-blast machine.

The principle involved lies in the fact that when air at high pressure and velocity is compelled to take an abrupt change of

direction, the heavier particles of air containing the moisture, by their momentum, will strike the walls of the apparatus in which this change of direction takes place. This causes compression of the particles of air which tends to separate out the moisture and deposit it on the walls of the vessel.

Where the moisture is excessive, even if only at certain seasons, an after-cooler or reheater is a necessity. While the after-cooler is most effective, some plants have found satisfactory relief in the reheater, although its function is in no wise to eliminate moisture. Where considerable moisture is present the conditions should be studied and provision made as individual requirements may demand. Don't expect to get an even, constant flow with your abrasive made plastic by moisture in the air.

Interdependent Factors

Each function in the operation of a sand-blast is to an extent dependent on the perfect operation of the others. Therefore maximum results cannot be anticipated from poor or powdered abrasive even with dry air at high pressure. Both sand and the metal abrasives show some disintegration with use and the fine dust together with core and molding sand and all fine material must be removed constantly from the abrasive. This material has no abrasive ability, but it consumes air just the same. Clean, sharp, dry abrasive graded to the requirements of the work will increase the output amazingly. A complaint is recalled where investigation developed that the owner had mixed fine plumbago with a metal abrasive, anticipating a desired finished appearance, but the admixture of this material with fine metallic dust from the abrasive, unscreened before reuse, and an abundance of moisture had formed a bond that rusted into a solid mass requiring a cold chisel for its removal from the machine. The complaint in this case was that the sand-blast would not operate.

A thorough understanding and application of basic principles will save time, worry and expense. The manufacturer can generally straighten you out if the conditions are sufficiently detailed for a clear conception of the trouble, but the help of a competent service man will often more than repay the expense entailed particularly if some one in authority in your

own organization will co-operate to understand the trouble and guard against a repetition of the causes.

In closing, it is hoped that some help in reaching the results everyone desires may come from the points brought out in this paper, but as circumstances alter cases, don't attempt a too literal application to your own conditions if they are in any way unusual. Call in help as suggested; see that members of your own organization give their co-operation as fully and ungrudgingly as the counsel or service man is expected to and the results will not only fully please you, but you will be well paid for the time and attention given.

Discussion

MR. W. J. DEAN.—I would like to ask Mr. Gates what effect sand blast had on the speed of machining small castings, compared with the ordinary rumbling or tickling?

MR. H. D. GATES.—Well, in the ordinary rumbling there is a tendency to create scale on the outside of the castings through which your tool naturally has to cut before it gets to the metal. Sand blast, on the other hand, will remove all scale, and your tool expense will naturally be decreased. There cannot be any set figure for what that saving may be. It will vary in various plants and conditions.

MR. W. J. DEAN.—Have you ever heard any complaints of sand blasting decreasing the speed of machining?

MR. H. D. GATES.—No, I do not think I have.

THE PRESIDENT, MR. B. D. FULLER.—Are there any other questions? Gentlemen, if there are no further questions regarding this paper I feel moved to say a word about it myself, arising from experience covering a great many years in the installing of quite a number of different sand blasts of different types. I believe what Mr. Gates has said, that in almost every case the sand blast is an excellent,

paying investment. He has stated that it is wise to have a competent engineer. That also is true. But I want to tell you that almost every independent installation of a sand blast has its own problem; the character of the work to be done being the first consideration. After you have gotten your engineer and gone over the matter with him several times, and have gotten your drawings, I would advise you to take those drawings to somebody who has operated sand blasts for a number of years, and go over that with him. I speak advisedly, from experience. These are all matters of progress; but the engineer and the foundryman together, in considering the sand blast installation, will decide "this is the thing we want". Now, I am talking from my own experience. And after that thing is installed, and operated for a time, we find that it was not what we wanted. We find that there are different things, and essential things, about that installation which would have to be changed not only once but two or three times. Underneath, you would have to change the hose to from an inch and a quarter to two and a half—and innumerable things; a fitting underneath that was supposed to be, when we started, something advanced, and after two or three weeks it was thrown out, and we would not adopt it. So I say from experience with handling sand blast, that it is a difficult problem; and experience is one of the most valuable things to the engineer and the foundryman. You need the engineer, but after you get his opinion, get the opinions and ideas of somebody who has had experience.

Mr. H. D. Gates.—There cannot be any question about that, Mr. Chairman. Anything that tends to work satisfactorily to the user, must, on the other hand, be satisfactory to the manufacturer; and they should both work together to get the results desired.

Women in the Foundry

By C. E. Knoeppel and M. J. House, New York

The one factor that looms largest in the foundry industry today is employment. The draft has taken 2,000,000 men and will take 3,000,000 more. To maintain each soldier it is estimated that 6½ persons are required in industrial lines, which means 32,500,000 transferred from peaceful pursuits or private life to war activities. This is a fact that should be realized *now;* "the path of failure runs along the stream of procrastination."

But how are we to get this vast army of workers? The answer is: Older men, boys and *women*—there are no fair weather signs in the labor skies otherwise.

What would you think of a presumably sane business man or manufacturer who failed to insure his stock or his property—you would be likely to question his sanity, would you not? Well, isn't it a parallel case when, knowing the man-power of the nation is constantly being depleted, you fail to prepare for the inevitable? And isn't it patent that the greater the depletion numerically the greater the depreciation of the efficiency factor owing to the fact that since the flower of our manhood is being utilized for our defense, the remainder becomes progressively less fit physically? The remedy lies in preparedness insurance through manual training of our women.

Women Are Doing

Some skeptics may still exist who inquire: "But will women do?"

Don't you know they are doing? There are 1,500,000 women in war industries alone; in canneries, textile mills, knitting mills, munitions plants, shoe plants and elsewhere in this country, and in England they are employed even in shipbuilding, a ship having been launched on the Clyde recently built almost entirely by women labor. They are at the lathe, at the

forge, in rolling mills and foundries abroad and for many years have been employed by the Germans at Krupps, at Creuzot in France and elsewhere. They are engaged as section hands on railroads, as conductors on surface roads and subways, in tan yards, papermaking, glass bottle making, woodworking; in potteries, brickyards, metal spinning, paint and varnish making, sugar refineries and in so many other occupations we have been accustomed to look upon as belonging exclusively to men that there is not space to catalog them here.

The British war office is authority for the statement that in 1701 jobs at which women are employed, a woman is "just as good as a man and, for some of them, better."

The Pennsylvania Railroad Co. added 1481 women to its forces in June alone and there are now over 9000 employed as railroaders (exclusive of those in the general offices), working in no less than 69 classified occupations, including car repairs, locomotive cleaning, crane operating, on steam hammers, as laborers, machine hands, lever-women, drawbridge tenders, switch tenders, freight truckers, track walkers, turntable operators, crossing watchers, etc.

In England there are, according to Helen Frazer, out of a population of under 50,000,000 persons: 1,250,000 women in industries replacing men; 1,000,000 women in munition making; 80,000 women in government departments; 250,000 women on farms; 10,000 women per month joining the Women's Army Auxiliary Corps; and 60,600 women in volunteer Red Cross work.

In a large number of occupations in France and Belgium the women have always helped their husbands and, since the outbreak of the European cataclysm their bravery has been phenomenal; they cheerfully took up the burdens laid down by the men. The munition workers have been recruited from the servant class, from those whose incomes were insufficient, from the unattached class, etc., and they revel in their new-found independence.

Sex Problem More Fancied Than Real

As militating against employment of women in the foundry, there are objections urged by some founders on account of

the sex problem, but that is more fancied than real. As a rule they are able to care for themselves, and by careful selection the possibilities in respect of unfavorable results will be reduced to a minimum and by proper segregation and supervision will be eliminated entirely. Then there is, on the part of some, a chivalrous feeling, an instinctive dislike American men harbor in respect of having their women do men's work; there is a prejudice due to precedent and a prejudice due to lack of understanding of women's capabilities, both mental and physical. An inspiring lesson, both as to endurance and self-abnegation is being taught by the English, French, Belgian and Italian women and, while it is true that the proportion of physical frailty is greater in the United States than in some other countries, there is a large body of foreign-born women accustomed to bear the burden of strenuous toil even to having served as team-mates for oxen before the plow. Women may be found fully qualified for many classes of floor molding, bench molding, machine molding, coremaking and even pattern work, as there are many of them handy with tools and no more prone to thump their thumbs with a hammer instead of the nails than their skeptical brothers. We admit they are in the minority, but they exist.

That they have succeeded abundantly in munition plants as machine hands has been fully demonstrated. As coremakers, experiments have proved them to be fully capable, more conscientious and productive than men and they are not found absent on "Blue Monday". On intricate floor work, there would be hardly time to teach them during the cycle of the war and the same is true regarding the more difficult phases of bench work, but they will be found quite equal to the plainer types of both and we venture the prediction that on machine molding they will be found more apt than the average man selected for such work.

Are More Deft of Touch

That they are more deft and delicate of touch cannot be gainsaid and their faculty of intuition would prove of value, too, in lieu of reasoning in many instances. The advisability of intermingling the sexes is open to serious doubt, in the beginning at least, owing to probability of annoyance on part of the

males, but in the larger plants it may be avoided by assigning women to separate floors and their presence in the foundry would tend to create a demand for better conditions than now prevail in many plants. Reforms would be demanded from a sanitary standpoint, there would be a general clean-up and some plants would profit greatly by the regeneration. As conditions improved, women would gain courage through environment, and would break away from tradition which ties us to certain customs because father did it.

In *The Foundry* for December, 1917, W. L. Churchill relates a very interesting experience in the replacement of men as coremakers by women. Special facilities were created for them, agreeable surroundings, clean and comfortable rest and lunch rooms, special entrances, different starting and quitting times and in fact, all the comforts of home save a manicurist and a corn doctor. But it paid, and what more do you want? In addition, a better atmosphere was created throughout the plant and *an increase in efficiency.*

Many increases in production might be cited, but one will serve to illustrate our contention. We are not personally conversant with the circumstances, but are reliably informed that in the core-room of the Bessemer Foundry Co., a job previously costing about $5 was done by women for $1.80. That's going some!

When trained as coremakers some will not object to a transfer to molding; it will become an evolutionary process. As timekeepers, women will be found, as a class, more inherently honest than men, not so ready to render false statements, although more sympathetic and susceptible to hardluck stories, but here again the question of selection is brought into being. No insuperable difficulty presents itself.

Dealing With the Younger Element

The younger element is of course more inclined to be frivolous and fretful, but if they get out the work, what of it? If they want to sing, let them sing. It's a well-known fact that during the heyday of the Mississippi packet lines, the roustabouts would load or unload a steamer in half the time they required when obliged to refrain from singing.

There is no question as to the intelligence and aptness of women as compared with the class of men usually employed on molding machines. It has been said a machine hand may be made of an ordinary floor laborer in two weeks. If this holds good, there are women who would learn in one week—they would be more adaptable than the average husky.

Some strategy may be required in the beginning and a campaign of education undertaken through the agency of the various organizations interested in women's work and in other directions (including even the home), to overcome the false pride impelling many daughters of honest workingmen to slave in stifling basement stores for one-third to one-half the wage they might earn because they fear to soil their hands, fancy the storework more genteel and find greater opportunity to parade their fancied charms in summer furs and finery to the extent of their earnings in the fond belief they are deceiving onlookers as to their social standing, while poor old Dad holds the feed-bag. Even some of these may be won over through their emotions, their realization that they are performing a patriotic duty and enough others will be readily found when, as in Mr. Churchill's case, they find they will be treated as human beings, will have pleasant surroundings and be protected from annoyances. Many women who have been reared in affluence have gone into war-work involving great personal sacrifice and their example will encourage others.

Women Pour Iron in Europe

We wonder if a molder's or a coremaker's job is much harder than that of a woman at a wash tub the livelong day? Of course, it is not supposed they would be required to pour off, yet they are doing such work abroad.

There are many engaged in drudgery, tied to long hours, lacking companionship and poorly housed, who will gladly embrace an opportunity to earn better wages, and, if as predicted, 5,000,000 men are taken for military duty, their places must be filled. Not all will return—more's the pity! and the vacancies must be filled permanently.

The need for workers will not end with the war, for Europe must be rebuilt—and that largely by America. Years will be required; hundreds of thousands of foreigners are preparing to return to their own countries and their places must be filled. Our returning army will not be sufficient to supply the demand.

If any of you fail to prepare for the inevitable you will be at a disadvantage, for many will and the result will be as in the case of the dog Abe Lincoln used to tell about who munched the cartridge. Lincoln's answer to the question as to what happened to the dog was: "Well, he wasn't much of a dog afterwards."

In connection with mobilizing woman power in the war, two books recently published are of interest: "Women Wanted," by Mabel Potter Daggett, and "Mobilizing Women Power," by Harriet Stanton Blatch. Both authors are well known, able writers.

A Study of Conditions in Europe

Courage and optimism are the dominant notes of Mrs. Daggett's book on the present status of women. In 1916 *The Pictorial Review* sent Mrs. Daggett abroad, with letters to everyone who could throw light upon her subject, to find out just how much and how well women were replacing men, and just how permanent their place in industry and commerce might be expected to be.

Traveling in Europe in wartime is not the simplest matter in the world, and it took all the passports, certificates, cards of identification and authorizations that this able journalist could muster to pass back and forth over the English channel, and to gain permission to visit the front. Visit the front, however, Mrs. Daggett did, and saw what is left of Rheims, the archbishop's palace flat on the ground, the cathedral in process of being utterly wrecked, and yet—was it an omen to Mrs. Daggett on her women's mission—unharmed in the public square, triumphantly facing the future, sat Joan of Arc on her horse, the one bright sign in the surrounding acres of desolation marked by small black crosses.

Mrs. Daggett's message to the world is that at last women are wanted outside the "woman's sphere", and that "out there" among the wage-earning classes with part of the world's work on their shoulders they are healthier, happier, sturdier themselves and the world is improved by their presence. She tells of the 850 private residences in London which public-spirited women have turned into voluntary aid detachment Red Cross hospitals; of Margaret Cox Benet, who braved all the perils of the Atlantic under the rule of "frightfulness" to get subscriptions for the American ambulance hospital at Neuilly; of the hospital of the American women at Paignton, Eng., started by Lady Arthur Paget; of the organization of Green Cross girls with their military headquarters in Piccadilly where she heard a slender, aristocratic-looking girl of 18 report to her commanding officer with a salute: "I have this morning burned three amputated arms, two legs, and a section of a jawbone; and I have carried my end of five coffins to the dead wagon." She was present when, after a Zeppelin raid, amid the crash of falling bombs and fire flaming suddenly in the darkness, a Green Cross ambulance drove up and khaki-clothed women set to work beside the police to pick up the dead and the dying and set the highway in order.

What Real Women Are Doing

She tells of Lady Ralph Paget founding her hospital in Serbia; of the Duchess d'Aosta doing ambulance work in Italy; of Lady Sybil Grant, Lord Rosebery's daughter, as official photographer; of the Countess of Limerick running a soldiers' free refreshment buffet; the Marchioness of Londonderry directing the cooking section of the Women's Legion; Beatrice Harroden, author of "Ships That Pass in the Night", in the uniform of an orderly at Endel street war hospital; May Sinclair at the Kensington war hospital supply department. These are notable instances, but Mrs. Daggett investigated as well the masses of women in industry, in the factories, the munitions plants, the motor factories, and her verdict is that wherever women go to work, rest rooms, dressing rooms, day nurseries spring up and not

only are the women better off, but the conditions for the health and care of babies and children improve.

She tells the story of Emilienne Moreau, a little girl of Loos, who took care of an entire family and turned her house into a first-aid station; of Madeleine Donau, the youngest girl who has been decorated by any government, who, when the village baker went to war turned in and ran the bakery for her village and countryside. She was but 14 years old, but she saw to it that for a radius of 10 miles no household missed the daily supply of bread. Mrs. Daggett's book makes one pause and reflect; it will uplift and encourage those who believe in democracy and freedom. It will disgust and dishearten those whose faith is set upon autocracies in government, society or homes.

Mrs. Blatch tells what the women of the warring countries in Europe are doing to help their respective causes and of how much more American women might do than they have thus far accomplished. The author has investigated the work of women in both England and France since the war began and her concise description and discussion of their achievements are fully informed and written with deeper insight than have been most of the numerous articles on the same subject. She lived in Germany before the war enough to be familiar with conditions there, and her very interesting chapter on the work for war of the German women is a contribution of real value, since it is upon a subject on which very little is known.

Thousands of Idle Women

The country is beginning to say to its men: "Work or fight!" And there will soon be no idle manpower among either rich or poor. Not a few people are beginning to think a similar sternness should be shown to the womanpower of the country, for there are many thousands of entirely idle women and many more thousands of the near-idle class. How much such women could do that would help to speed the war to a quick and triumphant conclusion Mrs. Blatch shows in pages that are crammed with facts and arguments. She makes it evident that there is already a labor shortage in this

country, and proves that it will soon be a much worse shortage.

Then she asks, shall it be met by imported coolie labor or by the willing hands of strong young American women? Her conviction is that it will be better for both the women and the country to let them take hold as earnestly and completely as they have done in England, France and Germany. She thinks that in all Great Britain there are hardly a million women—and they are mostly housewives—who are not mobilized in the country's service. In France there is hardly a woman who is not working to her utmost for her country in one way or another. They have found ingenious ways, many of which Mrs. Blatch describes, of making their labor tell for France. One of these is the munitions work in the home, which has helped greatly in making France more efficient than England in the turning out of munitions. The immediate and complete mobilization of the womanpower of Germany, Mrs. Blatch thinks, is one of the reasons why that country has been enabled to stand upright so long, because it has made it possible for her to "use every brain and muscle of the nation".

Mrs. Blatch tells at some length and with cordial appreciation what American women are doing to help win the war, but she devotes equal space to indicating some of the many ways in which they might do much more. And with words at once stern and ardent she urges them to take up their full share of the burden, which they are not yet bearing, and not only help their own army at the front, but also lighten a little the overburdened shoulders of the women of our allies.

Common and Preferred Sense

In "Keeping Up With William", Irving Bachellor, in his airy fashion sums up the German situation and, although entirely in lighter vein, it contains much food for thought.

The Honorable Socrates Potter, who once told us about "Keeping Up With Lizzie", serves again as Mr. Bachellor's mouthpiece, expressing this time his views on the subject of "Keeping Up With William". He declares that there are "two kinds of sense in men—common and preferred", the

latter representing "an immense bulk of inherited superiority and an alleged pipe line leading from the king's throne to Paradise". This second kind of sense flourishes, it seems, on hot air, and, after having imbibed a sufficient quantity, there comes an attempt on the consumer's part to improve morals by "taking all the nots out of the Ten Commandments". In Germany, according to the Honorable Socrates Potter, "every school, every pulpit, every newspaper, every book, became a pumping station for hot air impregnated with the new morals." The subsequent results may be witnessed in Belgium and elsewhere.

The common sense of Germany, as Mr. Bachellor states, and few of us will feel at all inclined to deny, has become "the sense that is common only among criminals". And this is partly because the people have handed their consciences over into what they regard as the safekeeping of the kaiser and the bundesrat, the result being that they are now "burglars in this great house of God we inhabit, seeking to rob it of its best possessions". Mr. Bachellor declares, what we all know, that the German soldier is utterly depraved, and he goes on to warn us of the need of establishing a moral quarantine here, for it is his opinion that "the Huns have already invaded America. Their gun is the camera, their ammunition the moving picture". He considers that through the medium of "our theaters, now largely in the hands of the Germans", the taint of Teutonic moral degradation is being rapidly spread.

Mercier and von Bissing

Brand Whitlock's story in *Everybodys,* contrasts Cardinal Mercier standing up to Germany like an old lion, daring the Huns to do their worst, with võn Bissing stalking over Belgium like an evil old bird of prey, his preposterous great cavalry saber clanking against his skinny shanks, viewing and abetting the horror of the ages. The truths he tells absolutely defy the wildest flights of the imagination; horrors not only unspeakable but unthinkable. Dr. Newton Dwight Hillis tells of 1000 authenticated cases of outrages the recital of which are enough to make the blood of an

ascetic run riot in his veins and inflame the passion of murder in the mind of a sybarite.

As further evidence of the ability of women, note the following from the *New York Sun* of March 9, "British women have clearly demonstrated their superiority over men in the manufacture of gun shells. Sixty-one per cent of all the shellmakers in Great Britain are women and this dilution of labor is continuing rapidly, it was stated officially here today. It is found that the greater the percentage of women the greater the output.

"The forthcoming monthly bulletin of the bureau of labor statistics shows that in a 10-hour day women are able to turn out twenty-four 9-inch shells, whereas 10 or 11 is the average for men."

In order to obtain a consensus of opinion upon the subject of women in industry, a questionnaire was mailed some months ago to manufacturers all over the country and to prominent labor leaders as well.

A condensation of the replies shows that the need for more labor power exists and will become increasingly urgent as time proceeds. Some attempts at employing women have failed owing to opposition of labor unions, and leaders as acknowledgedly intelligent as Frank Morrison, secretary of the American Federation of Labor, and Peter J. Brady, president of the New York State Allied Printing Trades Council, indignantly denied the existence of any shortage of labor and decried the necessity for employment of women. They will be won over, however, as the unions have been won over in England, where they are staunch supporters of the government; they have stopped all discussion of the rights of labor and capital.

No Time For Our Private Fights

This is not a time for a debate of labor rights or the rights of capital, nor is it a time for discussion of your rights or my rights. The question squarely before the country, which we—100,000,000 of us—must answer *now* is—will we be free or a vassal people? If I have an aching tooth or an arm blood poisoned to the shoulder, no discus-

sion is necessary as regards what to do first. I want to see labor have a greater industrial liberty, more say in the conduct of business and greater earnings than ever before, but first I want to see this war won, and not by Germany, in which event the rights of all of us would be taken care of by that philosophy called German kultur.

There have, of course, been abuses of the opportunity to utilize women labor, as indicated by the following statement by Miss Pauline Goldmark concerning an investigation she made of a factory in Zanesville, Ohio:

"The majority of the women at this plant are engaged at hard labor such as loading scrap iron, sorting scrap iron, wheeling iron castings in wheelbarrows, etc. The women loading scrap, and sorting the same, work out in the yards, with no protection from the intense rays of the sun or weather. These women wear overalls and large brim hats. They hand the iron up from the ground to others in the cars, who pile it. The hours are nine a day, 54 hours a week and one-half hour for luncheon; wages 20 cents an hour and $1.50 deducted each month for relief purposes. Men are given 21 cents an hour for labor of the same class."

A labor paper, *The American Federationalist,* is much concerned over the possibility of an uncontrolled use of women labor. It says:

"In Cleveland between 75 and 100 women are running Bradley hammers in one shop. Women are wiping engines in the round house at Akron, Ohio; many are running engines in the machine shop and doing other laborious work around large manufacturing plants. One woman has been employed by the Baltimore & Ohio railroad as a shop hand; she packs journal boxes, which are on the axles of wheels and must be filled with waste and oil. Flag-women have appeared on railroads. Women are employed in the foundry trade, in machine shops and munition plants. One lumber yard in Chicago is reported to be employing women to handle lumber. Truly there can be no justification for employing women with so little discrimination. We cannot disguise the fact that during the progress of the war women may be employed in constantly increasing numbers, but surely our nation has

enough intelligence to see that women are not employed in handling Bradley hammers and doing the roughest sort of manual labor for which they are physically unfit."

Contrasted with these are many examples of employment of women to the mutual advantage of themselves and their employers under conditions making their employment both agreeable and healthful, but the limitations of a paper of this sort precludes their recital in detail.

Two Principles to Follow

The questions of ability, adaptability, reliability and productivity all having been determined in their favor, there remains the factor of reward. As a rule, it has been the practice to pay women less than men, but the present crisis will eliminate the differential, as it should, a square deal becoming the rule instead of the exception.

One principle which would be given consideration in the matter of using women is as follows:

Most of the women who will go into industry are the future mothers of the race and the wives of our sons and must not be exploited. Another which must be adhered to in safeguarding our women is:

There must be no charity about what is done nor must the attitude toward them be a patronizing one.

With these in mind, we can proceed to the matter of our questionnaire. The questions, which first appeared in 100 *Per Cent* for December last, were as follows:

1.—How are we going to find the immense army of women needed?

2.—What basis shall we use for selecting women for industrial work?

3.—What efforts shall we make to provide clean, wholesome living conditions?

4.—What changes will we have to make to provide proper working conditions?

5.—What social conditions will we have to provide?

6.—What hours should women work and how about rest periods, fatigue and the like?

7.—How will we arrange to subdivide and arrange the operations so that women can efficiently perform them?

8.—How will we train women and who will do it?

9.—What steps will be necessary to induce the full co-operation of

a—Labor unions?
b—Organizations of women?
c—Our government?

10.—What steps should be taken to change and unify the state laws with reference to woman labor?

11.—How shall we adjust and arrange the wages of women?

12.—What will we do with reference to woman labor after the war?

In other words, these questions had to do with location, selection and training of women; conditions, working, living and social; the work to be done by women; hours, fatigue and wages; existing laws; co-operation of the labor unions, women's organizations and the government, and the post-bellum factor, all of which are essential considerations in any intelligent presentation of the subject.

The questionnaire attracted no little attention and we understand that it will be a subject for discussion at the next meeting of the industrial betterment committee of the National Association of Manufacturers. A great many requests have already been made for the conclusions, including government officials interested in the subject.

To place the results of this investigation in the most logical order, it was decided to rearrange the subject as follows:

A—The Work to be Performed by Women.
B—Find the Women.
C—Selection of Women.
D—Training Women.
E—Wages, Hours and Fatigue.
F—Working Conditions.
G—Living and Social Conditions.
H—State Laws.
I—Co-operation of—
  1—Labor Unions.
  2—Women's Organizations.
  3—Government.
J—Post-Bellum Considerations.

Let us now consider each in their order.

A—The Work to be Performed by Women

We cannot go exhaustively into the opinions expressed, but the following will illustrate the trend of the conclusions:

It was thought that insofar as might be practical, machinery should be rearranged so women could be worked in groups.

Further, women should be given different things to do during the day, to avoid over-specialization and to relieve the monotony which inevitably follows when a person does the same thing day in and day out.

Men should set up work excepting in cases where rigging machinery is a comparatively simple and easy task. It was felt that a safe rule to follow in determining, what women could do, would be: (a) Experienced men for difficult and complicated work; (b) laborers for heavy manual work; (c) women for light, simple or semicomplicated operations with men setting up the work.

For instance, one field where women could work to advantage would be toolmaking, a line of work which calls for the very qualifications women possess—neatness, accuracy, precision, dexterity and quickness. In other words, an analysis of work, based on a consideration of the above fundamentals would, very quickly, in each department, plant and industry, determine what women could and could not do.

A list of permissible operations for women could then be worked up, by the government or under government direction, and industry generally advised as to the field for women, along the lines followed in England.

B—Finding the Women

After determining the nature of work which women can perform with safety to their health and strength, the task becomes one of finding the women who are fitted to take up industrial occupations. Where are we to find them? How are we to obtain their consent to enter the factories?

Unquestionably, a great many women could be recruited from the ranks of those known as household servants, for in this crisis we could do very easily without servants. Then there are the childless married women, who could serve all of their time, and the married women whose families have grown up and who could serve for part of their time. In the socalled idle and leisure class, many women could be found to assist as well as many unemployed women who would like to work.

There are also the large number of wives and sisters of soldiers who have gone to camps or to the front. A large

number of women from the rural districts, not directly engaged in agricultural pursuits, could also be recruited. We are using colored men, why not colored women under a colored matron? Then there are many wealthy girls whose patriotism could be appealed to. By far, the largest number could be drawn from the families and friends of those already employed in factories. At any rate a review indicates that there would be plenty of women to draw from if they are needed.

The next point is how to induce them to enter industry. It was felt that appeals could be made through the following:

Women's organizations.
Schools.
Y. W. C. A.
Epworth Leagues.
Catholic societies.
Churches.
Factory bulletins.
Moving pictures, showing women at industrial work.
Industrial exhibits showing, through women, how factory work is done and what is made, women to be admitted free.
Departments of labor—state and national.
Associations of manufacturers.
Editorial support by newspapers and magazines.
Advertising, like the appeals to shipworkers and ordnance workers.
Magazine and newspaper articles.
Public lectures.
Campaigns putting before the women of America what the women of England have done.

It was felt by several that the basis of the appeal should be to so place the matter before women as to insure against their losing caste by going into the shops, that it would not be degrading—but big, patriotic work, and a real help in this crisis.

A number thought that women could be recruited the same as men are employed, through making it known that women were wanted and engaging the best of those who applied for work.

Still others were of the opinion that through women employment managers and the employment exchanges throughout the country, plenty of women could be located and induced to apply for work. One very good suggestion was to have the government work through the National Chamber of Commerce, wherein labor, women and the manufacturers would

have representation. Another suggestion was that a campaign like that of the Red Cross could be instituted and secure sufficient women workers for industry.

C—Selection of Women Workers

Knowing the work that women can do in industry and having worked out plans for inducing women to apply for work, the next step is that of selection. This question seems easy of solution according to the answers received—simply match qualifications against requirements. In other words, the task is one of determining character of work and selecting the types of women who can do it, or to put it another way, find the women who can work and then train them.

One suggested that women be tried at different tasks before determining what they might best be suited for; another that a list of the various kinds of work should be posted, showing the women the nature of the work as it is done in the shops, letting them select the kind they feel they are best fitted for.

Several felt that it should be handled through women employment managers and women supervisors, the same as men, only much more carefully. It was also felt that after employment, close supervision for from four to six weeks should be made to see to it that requirements and qualifications did match.

One very excellent idea was that women should be classified by local boards, not only with reference to physical and mental fitness, but home demands as well, and that employers should requisition these boards, on approved forms, stating kind of work, location of plant, conveniences for female labor, housing conditions and other important factors affecting women workers.

In many cases women could take up the same work as their fathers, brothers and husbands, because of the ability of the men to assist and instruct the women in mastering the various phases of the work they are familiar with.

D—Training the Women

Many of the women who apply for industrial work will be totally unfamiliar with factory work or the operation and

handling of machinery, so that the matter of training becomes doubly important.

It will be necessary to organize a system of competent instruction, if the change to women employes is to be made rapidly and efficiently and the heavy loss in production, while they are learning, is to be reduced to a minimum. To be prepared, the preliminary work toward organizing a crew of instructors should be started as soon as it is decided to use women workers.

The instructors to be used should be selected from the fastest workers in the organization. The mistake, however, should not be made of thinking that any fast operator will make a good instructor. They should be selected for their ability to explain things clearly; for pleasing personality, tact, patience, sympathy and consideration for the rights of others; for ability at performing the tasks they are to teach, and wherever possible unusually masculine men should not be put in charge of instructing women.

One suggestion was that instructors be recruited from the women of a community who have shown executive ability, training them to in turn train others. Another good plan would be to let women work part time as a step toward training women who could be used as forewomen. Instructions should be given first by men, then by the women who become most proficient.

As studies of operations were the first step recommended in determining what work women could do, they can again be used for purposes of training to excellent advantage.

Another suggestion was to take care of industrial training of women workers through co-operation with the Y. M. C. A. and the Y. W. C. A.

E—Wages, Hours and Fatigue

The matter of wages, hours of work and fatigue is most important in connection with the utilization of woman labor. It can well be said that the success or failure of the movement depends to a great extent upon what we do with reference to these things.

The answers with reference to wages narrowed down to the following: (1) Determine standards and pay according to

performance; (2) piecework, with minimum wage guaranteed; and (3) weekly wage for a time, then piecework.

The principle "equal pay with men for equal work" was subscribed to by practically all who answered the questions. One replied "Leave it to the women", feeling that they were amply able to take care of themselves. Several felt that earnings in advance of those paid men should be offered to atttract women workers and secure interest and co-operation. Some were of the opinion that while women should receive the same as men if they produce the same, they should receive less if they do not produce as much, but more if they can exceed the production made by the men.

All through the answers, it was plain to be seen that the feeling was—No exploitation of women—and one went so far as to urge that the government take steps to prevent any possible exploitation in the unorganized industries. Our review indicates quite clearly that organized labor has nothing to fear from the manufacturing world as regards women in industry.

In analyzing the questions as to hours, rest and fatigue, the conclusions were: (1) No night work; (2) no overtime; (3) no Sunday work; (4) half Saturdays off; (5) an 8-hour day, some urging a 54-hour week; (6) a rest period in the morning, and in the afternoon, in addition to the lunch period, and varying from 10 to 20 minutes; and (7) experiments to determine rest periods and fatigue factors in work of a very fatiguing nature.

If a plant is not of a size that warrants retaining a doctor and dentist permanently, arrangements should be made with local practitioners to handle all plant cases or else several concerns can associate and retain one medical and dental staff. However, in this case employes will require additional time for medical attention and will lose that much more production.

Employers and employes should get together on the important matter of wages, hours and fatigue, and work out definite rules and procedure.

F—Working Conditions

Another very important factor in connection with the utilization of woman labor is the matter of the conditions under which they work. Select the best of women, pay the best of

wages and make conditions agreeable; if working conditions are not right, the result is bound to be both discontent and dissatisfaction.

All workrooms should be thoroughly lighted; it helps the speed and accuracy of work. A generous use of white paint on walls and ceilings and even on machine bases, will accomplish wonders in improving the light and, next to this, clean windows are a great help.

With regard to ventilation, you will find languor, headache and a disinclination to work where the air is allowed to get stale. Fresh air should be admitted and bad air removed from rooms in such manner as not to create drafts. The temperature of the rooms should be kept constant. The best temperature to maintain varies in accordance with the strenuousness of the labor performed in the room.

The question of the position at work is especially important for women as their health and efficiency are largely dependent upon it. Wherever possible their work should be arranged so they may be seated and the chair or stool designed so they will sit in an erect position. Where their labor requires standing a large part of the time, high stools can be designed on which they may rest in a semisitting, semistanding position. Special attention should be given to arranging their work about them so that everything needed is within easy reach. This not only adds to comfort but greatly speeds up the performance of the operation.

Labor-saving devices should be installed wherever possible, to eliminate lifting and handling by women. Safety appliances should be given the most careful attention and rigid safety rules determined and maintained. Women should first start on the lighter tasks and as they become proficient can take up heavier work, if physically able to do so. Under no consideration should women be placed at what might be called dangerous occupations. They should not be placed in departments where gas fumes or dust would prove detrimental to their health, nor should they be subjected to intense heat or cold.

Women should be segregated, if this can be done, either by new buildings or by rearrangement of departments or machines. There should be no smoking by men when men and women

are working together, and it would be well to allow the women the right to sing as they work. Arrange as far as possible to change the tasks during the day so as to furnish variety.

After lunch and during recreation periods, women should be allowed to completely relax and enjoy themselves, as this will be found to keep them in the best mental and physical condition.

Shops should be kept as clean as possible; dark nooks and corners should be done away with; all this will do much to make the shop a real second home to the women, whose maternal and womanly instincts should be appealed to. Are they not worth it?

Separate entrances for men and women should be provided, or better yet, men and women should arrive and leave at different hours, so there will not be that intermingling that is often so objectionable to women.

Working clothing of women should be standardized. If all are dressed alike, there will be less rivalry as to dress and less in the way of comment by the women regarding the matter of dressing. A matron should be employed where women are at work. Provision should be made for properly policing the streets when women enter and leave the works, to guard against having them molested by rowdies and loafers.

There should be dressing rooms, lunch rooms, toilets, drinking fountains, lockers and a hospital which can be used for a rest room during recreation periods. The provision of healthful working conditions, while important where men are concerned, is doubly so where women are used.

G—Living and Social Conditions

The matter of clean, wholesome living and social conditions can best be handled through organizing the manufacturers of the community, unless a single plant is of such size that the necessary investment can be taken care of without embarrassment. The women in the vicinity of a plant will frequently have their own homes where they will live, but those drawn in from the surrounding country will require clean, wholesome places where they can board at a cost consistent with the wages which you are able to pay them. Where adequate

accommodations are lacking, company boarding houses should be provided, as they assure the women meeting other women and having social intercourse. The lonesome woman soon leaves her job and goes home, where she is known.

The contentment of a woman employe might be said to depend one-third on wages and working conditions, one-third on living conditions, and one-third on good, wholesome amusement. The question of amusement is an important one and seldom receives the consideration it deserves. If a woman thoroughly enjoys herself during her hours away from work it will be difficult to induce her to leave the community she is in, even for higher wages.

Much depends upon these conditions and co-operation of such agencies as the Y. W. C. A. Women must be comfortably housed, fed and amused if you expect them to be contented.

But above all things, avoid all appearances of charity. They expect to pay their way and, while everything should be furnished them as cheaply as possible, there is nothing they resent more strenuously than patronage.

H—State Laws

As regards the matter of changing or unifying the existing state laws, there was quite a difference of opinion. Some felt that national legislation was immediately necessary, while others thought that the laws in the various states were satisfactory as they are.

One suggestion was that national legislation should set aside present laws, for the period of the war, after a standard set of rules governing woman and child labor had been developed, finally enacting a uniform federal law governing all labor.

Another suggested that state laws should be modified and corrected wherever necessary, to circumvent both unfair employers and labor unions.

From the answers received plus an analysis of the state laws, there seems to be a need for some national legislation of an emergency nature, so that standards can be set and then

maintained and, while it may not be as important as this, it was felt that much could be done by bettering the present laws.

I—Co-operation of Labor Unions, Women's Associations and the Government

LABOR UNIONS.—It was felt, according to the answers received, that the labor unions would not take kindly to the introduction of women labor and that we could expect to have the same trouble England experienced at first in her attempts to utilize women labor to the fullest. This will be especially true if the labor leaders take the stand that there is no shortage of labor.

In the first place no wholesale attempt should be made now to use women in industry. Man power should first be used fully and efficiently. Plans for women in industry should be worked out from now on, however, for in the event of a long war, which seems likely, women will be needed to the fullest extent. To this end steps should be taken by the government, by manufacturers and by women's organizations, to make organized labor realize the seriousness of the international situation. If public opinion cannot induce their leaders to see need of women in industry, sheer necessity will sooner or later force them to allow women to work side by side with the men.

To secure the co-operation of labor, there should be publicity and an appeal to show them the real situation as it is likely to exist in case there are several years more of war, in order to get labor to waive restrictions on output, and the use of women during the war, as England's labor did.

All steps should be fully explained at an early opportunity and nothing short of the utmost frankness on both sides should be considered for a moment. If these are agreed to, no difficulty should be encountered, especially if in the use of women there are the following considerations:

> *Equal pay for the same work; same hours; right of women to organize; suffrage; and maintenance of proper working, living and social conditions.*

If labor objects after the foregoing are provided, then it hasn't a leg to stand upon, and the government should step in

establish profits, arrange for compulsory arbitration, waive restriction on output and use of women labor, prevent cutting of rates and insure proper working conditions.

The war labor administration or the National chamber of commerce, or both, should—in conjunction with the American Federation of Labor and the council of national defense, find a solution of the labor clash during war times.

WOMEN'S ORGANIZATIONS.—No difficulties are expected in securing the full co-operation of women's organizations, in fact they are doing nobly at the present time and are doing all they can to win the war.

In getting them to work to the fullest in making "Women in Industry" a real success, the appeal must be made to patriotism, sense of duty, the need for them in this crisis and that the underlying considerations will be, equality with men; earnings as a basis for social standing; proper working, living and social conditions; right to organize; no loss of caste because women work in shops; no exploitation; same pay for same work; enforcement of better laws and the maintenance of high standards.

GOVERNMENT.—What was said with reference to union labor and women's organizations, applies equally well to the government and to labor. The politicians must be made to see the need of women in industry in increasing numbers, and have the courage to come out and say so. The Chamber of Commerce of the United States can be a factor along these lines. All present work should be co-ordinated, and any laws against the proper utilization of women in industry should be repealed.

The new war labor administration should make exhaustive investigations of this whole subject and with government officials in conjunction with representatives of manufacturers and labor, devise ways and means of using our women in industry.

J—Post-Bellum Considerations

The question—"What about woman labor after the war?"—is a most important one. One of the reasons labor is opposed to women in industry is its fear that women will remain

to displace men after the war is over, which makes a consideration of this point necessary.

Many of those who answered the question felt that the situation would take care of itself when the war is over. Many soldiers will marry upon their return; women in the factory will meet and marry shop men and take up domestic work later on; other women who desire to do their share during the war will go back to their prewar occupations or activities, to their homes, offices, life of leisure and the like; those who become skillful and like industrial work will want to remain in the shops. It was felt by many that if the war lasts long enough, we will number our dead and disabled through injury or disease by the hundreds of thousands, thus depleting the industrial ranks. Thousands of the disabled will have to be supported in many cases by the wives or sisters of the crippled or diseased, all of which will call for many women remaining at work.

The opinion of many is that the reconstruction is going to call for so much in the way of replacements, new construction and the like, that labor will be in great demand for years to come and that this very demand will induce many women to remain in industry.

The general feeling was, however, that the men who return should be given back their old jobs or that new work should be found for them; that home would make the real appeal to women and many would drop out for this reason, and that while the life of independence and high wages would hold a great many at work, many others would drop out because of not finding industrial work to their liking.

Several other factors must also be taken into consideration. Many foreigners will return to their home countries after the conclusion of peace, which will make large gaps in the ranks of industrial workers.

Steamship companies report that from 500,000 to 1,000,000 aliens are planning to go back to their respective countries when the war is over. About this point, Frederic C. Howe, commissioner of the port of New York, says:

> "Instead of surplus of labor there may be quite a universal shortage and those countries that make

conditions most attractive are going to secure immigrants and keep their own population."

In other words, we may change from an immigration to an emigration nation.

It looks very much as if the proposition will adjust itself, as men and women will fit themselves for tasks they can do best. We cannot get away from this basic argument: If there is a dearth of men, women will be needed and will work, whereas if there is an oversupply of men, women will have to give way. The law of supply and demand may be expected to work here as in other things.

As a constructive measure, a national commission should be appointed by the government or the war labor administration to consider this very point.

The replies to the 12 questions by Hilda M. Richards, chief of women's division, department of labor, coincided with our own views as did also those of many others.

Standards

The standards set up by the ordnance department, quartermaster's department, women's committee of council of national defense, Women's Trade Union League and Executives' Club of Detroit practically agree upon the following:

Adult labor only.
Hours of labor—Eight hours.
Prohibition of night work.
Rest periods—Time in middle of each working period.
Time for meals—At least 30 minutes, an hour if possible.
Place for meals—Not in the workshop.
Saturday half holiday.
Seats wherever possible—For those who must stand, seats to be used at regular intervals.
Lifting weights—Not over 25 pounds repeatedly.
Equal pay for same work.
Technical and trade training—Open in all schools and colleges on equal basis.
Recruiting committee—To investigate applications from women with children to see if children are properly cared for.
Sickness insurance.
First aid provision.
First class supervision of working conditions.

Data contained in "Women's Work in War Time", by W. Irving Bullard, and issued by the Merchants National

bank, of Boston, furnishes information of great interest and value concerning replacement of men in Great Britain by women. The various lines of work are given in detail in addition to the several processes upon which women are employed in each industry to advantage.

Jas. O'Connell, president, metal trades department, American Federation of Labor, expresses himself as follows:

"If women are to be injected into industry with a view to displacing male labor it must not be left to the haphazard methods usually adopted by the employer but with a well grounded set of rules, made to apply to all alike. Such rules should provide for wages, hours of labor, living conditions, working conditions, social conditions, questions of rest periods, class of work that women are best qualified and fitted to perform, under what conditions they should be trained into industry, their right to organize and associate themselves together for mutual protection, necessary changes in national or state laws to protect them, and the provisions necessary for their future employment at the end of the war. All of these conditions could be scientifically and satisfactorily worked out through conferences called by the department of labor between representatives of employers and organized labor."

The health of munition workers' committee of Great Britain particularizes quite minutely in line with the recommendations made in the foregoing in general terms, giving reasons why there should be restrictions safeguarding the health of women workers under six heads, as follows:

1.—Welfare Supervision.
2.—Industrial Canteens.
3.—Industrial Fatigue and Its Causes.
4.—Special Industrial Diseases.
5.—Ventilation and Lighting.
6.—Sickness and Injury.

What applies to munition plants will apply equally well to foundries except that there are certain conditions obtaining requiring special consideration, including fumes and gases.

Statistics

Much statistical data concerning output in relation to hours of work has been gathered and tabulated by Dr. H. M.

Vernon in respect of men, women and boys and with relation to light, medium and heavy work. The study was exhaustive and his conclusions confirm our own to the effect that the very heavy work should be left to the men, and that nothing is gained by long hours.

Reports from executives in widely separated parts of the country agree as to the success of women in metal working plants, hence it cannot be attributed to local feeling or racial traits.

The war can only end in one of three ways: Lose, draw or win.

If we lose, the women need not concern themselves about going into industry—the Germans will see to that. If the result is a draw, we can prepare our boys and girls for the supreme struggle in about 25 years. If we win, it will be when the 100,000,000 of us get behind the war as one man.

President Wilson said to the farmers:

"The culminating crisis of the struggle has come, the achievements of this year on the one side or the other must determine the issue."

May the Almighty help us if this is so, in view of the points brought out in the foregoing. May we awake to the seriousness of the war, kill off forever this mad dog of Europe, and destroy this poison which would set the world back a hundred years.

There must be no draw. We cannot lose, if posterity means anything at all to use. *We must win.*

How long will it take? Colonel Sir Berkeley Moynihan C. B., senior consulting surgeon of the Royal Army Medical Corps of the British army, said Nov. 8 last, before 1500 physicians and their wives at the Waldorf-Astoria in New York:

> "I am asked how long the war will last. I will say for America that the war will have just begun, when every man of military age shall have offered his life to his country; when your wealth, your souls and your honor have been offered, when you have mourned your dead by the hundreds of thousands."

When will it end? Let young Jimmy Gerson ("Over Here", by Earl Derr Biggers in *Collier's*) tell us:

> "I'll tell them when it will end—it will end when the men who trampled down Belgium and France, who kill wounded

prisoners with liquid fire, who murdered people like cattle, who ruined the fruit trees and burned their homes, it will end when those men feel the grip of the world at their throats. It will end when the crowd who started this war of lust and loot are in full retreat, when Willie down at Verdun is shouting to papa at Berlin: 'Come, for God's sake!' and papa at Berlin is screaming to Willie at Verdun: 'Run for God's sake!' It will end with the siege of the Rhine!

"That's when it will end if it's left to us fellows who are going over. We're ready to stand in ice water up to our waists, to live with rats in the rain of German shells, to go over the top and be finished. Nobody need worry about our boys over there. But how about the bunch left over here—the crowd that wants to know how soon it will end? Are they going to queer us? Are they going to fall for the German tricks? Will the pacifists turn their blood to water? Only one thing can do for us and that isn't the German army. It's our own people at home. Maybe some guy in Terre Haute will get tired putting three-cent stamps on his letters. Maybe some fellow in Cleveland will get sick of the graham bread. Maybe some fat little soul in Denver will get to worrying about his profits. And they'll come together and decide that it's no use fighting it to a finish—and where will we be? Done for, licked, finished; thousands of dead for nothing—all because the people at home hadn't the guts to stick it out!"

In other words, this war will be won when all have given their time, their money, and if necessary their lives to the cause. Multiply all the latent ability and resources of each person by 100,000,000 and what will we have? The kaiser in exile. If we don't, he may decide to move his capital to Washington.

You have your choice between civilization and a cross between a coyote, a jackal, a hyena and a weasel; that blond beast whose acts make the devil tremble for his throne, the mention of whose very name begets an indescribably sick and deadly loathing. It is a case of victory or verboten; sheckels or shackles; Stars and Stripes or stripes only; a God of love or a god of lust.

If it is to end as we want it then we must use women in industry—in the foundry industry as well as in every other industry.

Engineers—Their Relation to the Foundry in Saving Manpower

By E. S. Carman, Cleveland

The American people are just beginning to realize that they really never knew the correct definition of the word "saving". We have been an extravagant people, producing anything and everything to add to our comfort, and in the years gone by he was considered a genius who could create and produce, even at the most extravagant cost of labor and wealth, an article that would bring additional comforts to men; but we are today facing a new condition and he is considered a genius who can create and produce an article which will be the most destructive to man.

This business of war, in which the whole world is engaged, requires that every available man and woman be made to produce war materials with the greatest efficiency possible, and doubtless the war will be won by that group of nations which can produce the maximum with its available manpower. Therefore, we Americans have determined that every effort shall be put forth to obtain the maximum production per man in order to win the war. Progress in this line has been made in many industries; but the industry that most concerns us, as foundrymen and engineers, is that of the foundry.

Analyzing Foundry Operations

Let us make an analysis of the foundry and see whether or not we are getting the maximum production per man, and if not, let us place, if possible, the responsibility for not having obtained the maximum.

Foundry operations may be divided into classes as follows: Yard work, handling of pig iron, scrap, coke, flask equipment,

etc.; sand handling; molding; melting and pouring iron; and shaking out and cleaning the castings.

In the specialty foundry, the foundry producing duplicate castings in large quantities, there has been a satisfactory advance in the saving of manpower per pound of output by the installation and use of yard cranes, motor-driven yard trucks, electric magnets, sand conveying systems, molding machines, pouring machines, shakeout machines, sand blasts, tumbling mills, etc. The best specialty foundries are equipped with practically all of the foregoing and are still looking for other means to reduce manpower by the use of money-power.

The Engineer's Part

The engineer has had his part in the design and production of all the equipment named in the foregoing paragraph, which efficiently performs the function required of it. There is, of course, opportunity for further development and improvement, but during the war, if such as we now have available is made use of by the foundry industry in general, a very great saving of manpower will result.

The engineer has performed his duty in regard to the design of the equipment for foundry use, but I wish to ask the question, "Has the engineer performed his duty in regard to the *product* that the foundries are turning out?" As the foundry output is castings only, I ask again, "Who, if not the engineer, is responsible for casting design? Who is responsible for the casting with a core so large and heavy that it cannot be supported by the available core print, and, if perchance it can be supported, what about removing the core after the mold is poured? And then again, who is responsible for all the fancy beads, extending lugs, recesses, socalled tool clearances, sharp corners, joining thin and thick sections of metal and many other unnecessaries?" All of these retard production and in some instances prevent the use of machine molding, requiring instead the greatest manual skill to secure even a low production.

The engineers will answer, "Well, what is that to us? Shall we spend our time looking out for the foundry?

Fig. 1—Modern Foundries are Light, Clean and Healthful as These Two Views Show. Molding Machines Help Make These Conditions Possible

Does not the foundry give us any and most everything we design, and that too without speaking a word of complaint?"

Well, foundrymen, I'm ashamed to say it, but I believe they are right. For all these years you have gone on and on, giving the engineer everything he designs, putting up with the same old difficulties, and making the castings in the same old way. The foundrymen will admit that this is doubtless true and ask: "What can we do to help matters?" I reply, "Use all the knowledge you have, for the present, and endeavor to convince the engineers that they should give due consideration to foundry operations."

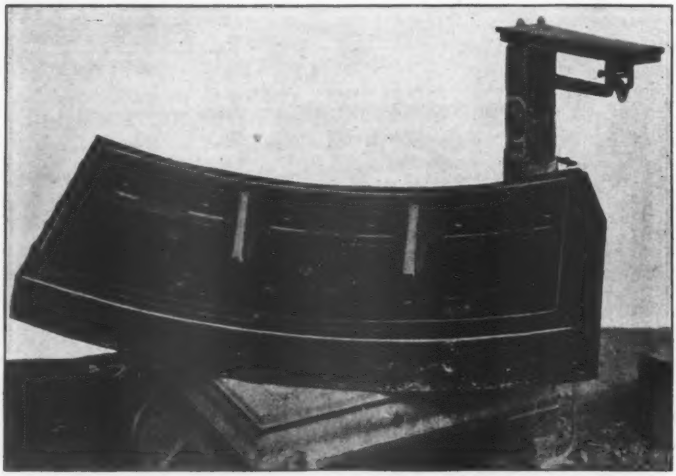


FIG. 2—TUNNEL-SEGMENT CASTING WEIGHING 1600 POUNDS

Is it not time that the foundries produced a man who by education and experience understands that castings, to be made successfully with unskilled labor, should not have some of the complications just mentioned? Let us train such man both in our schools and colleges and in the school of experience. Let us call him a foundry engineer, and when these casting difficulties arise, send the foundry engineer to the customer's engineering department, and point out the difficulties encountered in production, suggesting changes, and

FIG. 3—TUNNEL-SEGMENT MOLD MADE ON MACHINE

in engineering terms meet the objections of the customer's engineer and then offer a substitute. In addition, stay with them until the casting is changed or it is conceded and agreed that no change should be made. This method of procedure may seem slow and it may appear that it would require years to effect any change in the industry, but I believe now is the time to start.

Then again, because engineers in general are not conversant with what the foundry can do, there is a large amount of manpower being lost in machine shop operations. There are many machined joints being made today that can be made more cheaply and better by casting the parts integral in the foundry.

My years of engineering experience lead me to state that engineers in general, i. e., the large majority, do not thoroughly understand either pattern making or molding, especially machine molding, and consequently they are unable to design intelligently and in the most efficient manner. But in contrast the engineer is thoroughly familiar with and understands machine shop practice. In his education he has received instructions and experience in up-to-date machine shop practice, while in most cases his foundry training and experience was limited to old methods, and machines, if used at all, were not of modern design.

This lack of interest regarding foundry operations applies in some cases to the management as well, for we find them spending tens of thousands of dollars for machine-shop tools, where they are not willing to spend hundreds of dollars for foundry tools.

Now, foundrymen, why are these things true? Why not accept some of the responsibility of the present foundry conditions and then do your part in convincing the engineer and the management that the foundry can no longer be overlooked and considered a dirty and disagreeable place, not worthy of consideration.

Better Foundry Conditions

The specialty foundrymen have been and are trying to make the foundry a better place in which to work; but

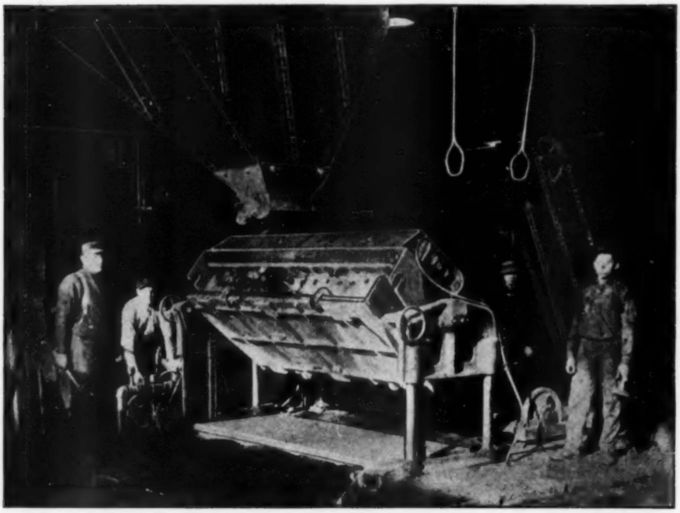


FIG. 4—JAR-RAM ROLL-OVER MACHINE USED IN MAKING TUNNEL-SEGMENT MOLDS

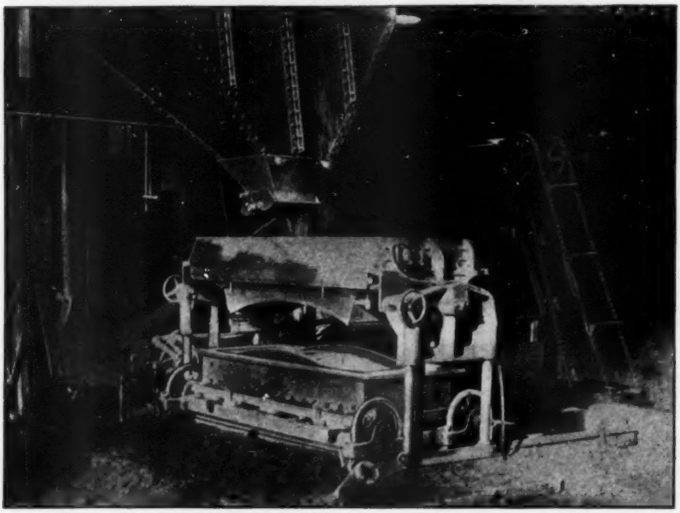


FIG. 5—MACHINE WITH MOLD ROLLED-OVER AND PATTERN DRAWN

FIG. 6—AUTOMOBILE CYLINDERS MADE IN QUANTITY ON MOLDING MACHINES

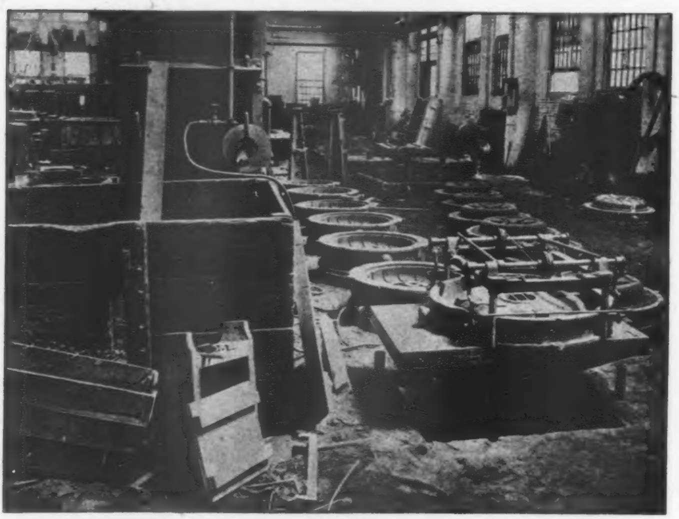


FIG. 7—WHAT A MOLDING MACHINE CAN DO IN A JOBBING FOUNDRY

there is no reason why the jobbing and other foundries should not be doing their part. The engineer will welcome your co-operation and when you work together for the good of both, then all foundries will be, as the specialty foundries now are, equal in progress to other industries.

The illustrations that accompany this paper will clearly and forcibly impress the mind with some new possibilities,

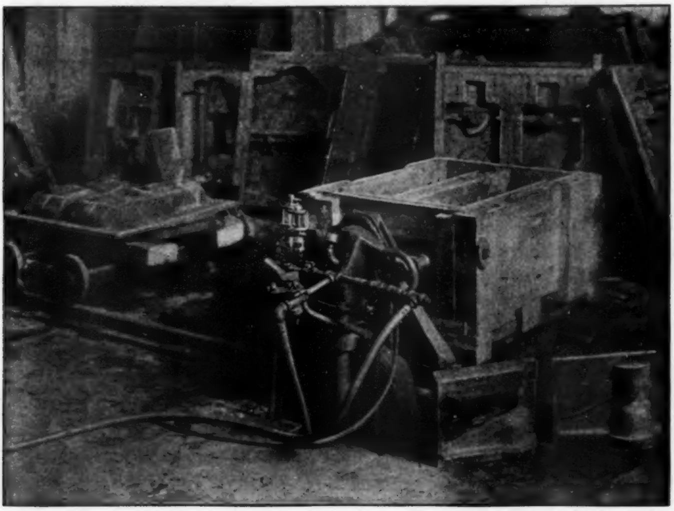


FIG. 8—MOLDING MACHINE ADAPTED TO A VARIETY OF WORK

especially those of general machine designing and its relation to modern machine molding. They also will show the good results that flow from properly preparing and making the patterns, all for the purpose of saving in the foundry the skilled manpower that today is so essential to build ships and make munitions to win the war. We have been accustomed to think of the foundry as a dark, dirty, dusty, disorderly and unhealthy place, but Fig. 1 shows that the modern foundry is as light, clean, clear, orderly and healthy as any other of the industrial shops.

Before proceeding in detail to show the advantages to be gained by the proper consideration of design, I wish

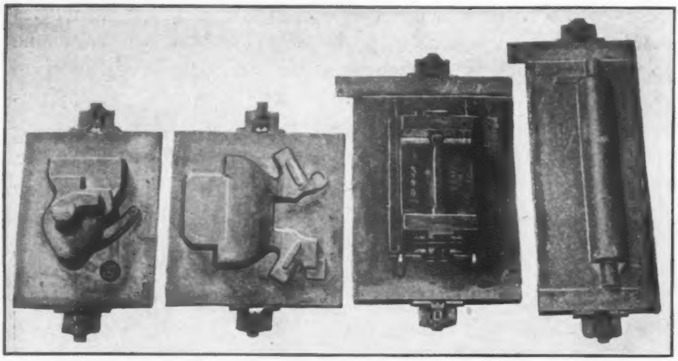


FIG. 9—A GROUP OF JOBBING FOUNDRY PATTERNS

to show a few illustrations that will give the engineer an idea of what modern foundry production really is.

Fig. 2 shows a tunnel segment casting, weighing about 1600 pounds. This particular casting was made in large quantities, requiring a continuous run in the foundry for about two years. Fig. 3 shows the mold with over-all dimension 8 feet 4 inches long, 42 inches wide and 14 inches deep. Observe in the background the large number of molds that are made and ready to be poured. Fig. 4 shows the machine on which the molds are made. In this view, the sand has been rammed, bottom plates attached, and the machine is in the act of rolling-over the mold. Fig. 5 shows the mold rolled-over and the pattern drawn. The output

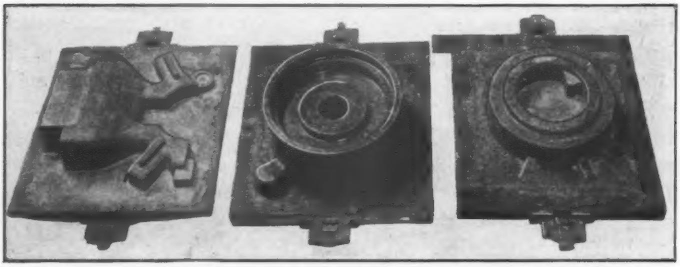


FIG. 10—ANOTHER GROUP OF JOBBING FOUNDRY PATTERNS

of this casting, before it was placed on the machine, was seven to nine molds a day with a skilled molder and helper, while the output of four laborers, working on the machine, was 141 drags per day. This was a daily performance for nearly two years. Fig. 6 shows an exceptionally large production from still another shop which is equipped with molding machines.

The foundries thus far shown may be termed special foundries, while that which we are most concerned about is the jobbing foundry or that foundry which does not have large quantity production from individual patterns. Therefore, Fig. 7 gives an idea of what may be accomplished in a day when a molding machine is used in a jobbing foundry. The machine shown here is known as a plain jolt machine. It accomplishes only a portion of the full amount of work required in making a mold. Fig. 8 shows a jobbing foundry machine of the roll-over type. The core boxes setting around this machine show how readily it can be changed to handle the many different boxes that are required for this work.

The roll-over jolt machine represents the greatest progress made in machine molding as applied to the jobbing foundry. We wish to keep in mind this fact as we further discuss this subject. Fig. 10 shows several jobbing foundry patterns made of wood and mounted upon wood pattern plates for machine molding. Fig. 11 shows a pattern as ordinarily made for hand-rammed floor production. Fig. 12 shows the same pattern mounted for machine molding. Fig. 13 shows another pattern as made for hand-rammed molding. Fig. 14 shows a similar pattern when made for machine molding. Figs. 15 and 16 show another large, long, difficult pattern after being arranged on boards for machine molding and before these changes were effected.

Proposed Pattern Making

All of these patterns after being placed on pattern boards for machine molding, showed an increased production of from 100 to 600 per cent, while records show that if the pattern is originally made on a pattern plate for machine molding,

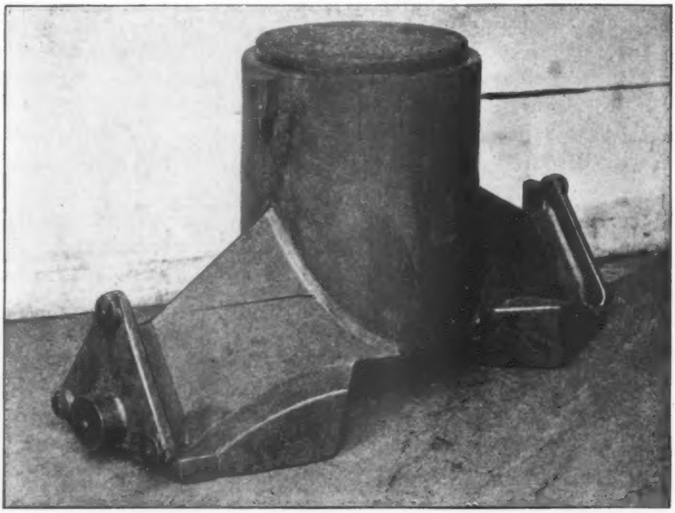


FIG. 11—A PATTERN ARRANGED FOR HAND RAMMING ON THE FLOOR

FIG. 12—THE SAME PATTERN MOUNTED FOR MACHINE MOLDING

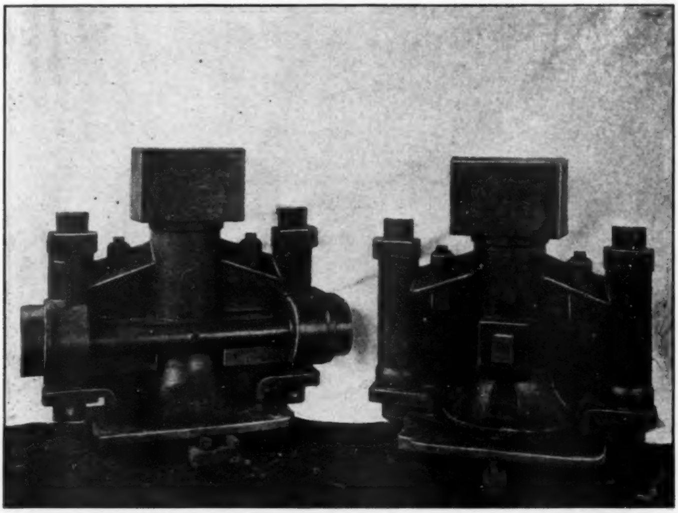


FIG. 13—A HEAVY PATTERN ARRANGED FOR HAND MOLDING

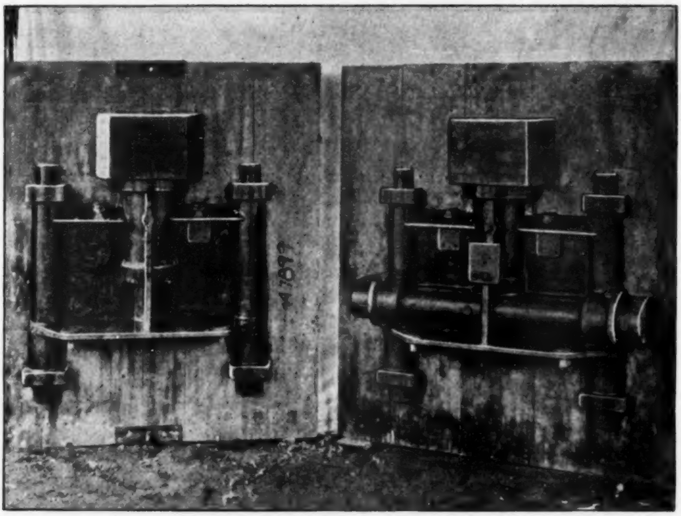


FIG. 14—THE SAME PATTERN MOUNTED ON BOARDS FOR MACHINE MOLDING

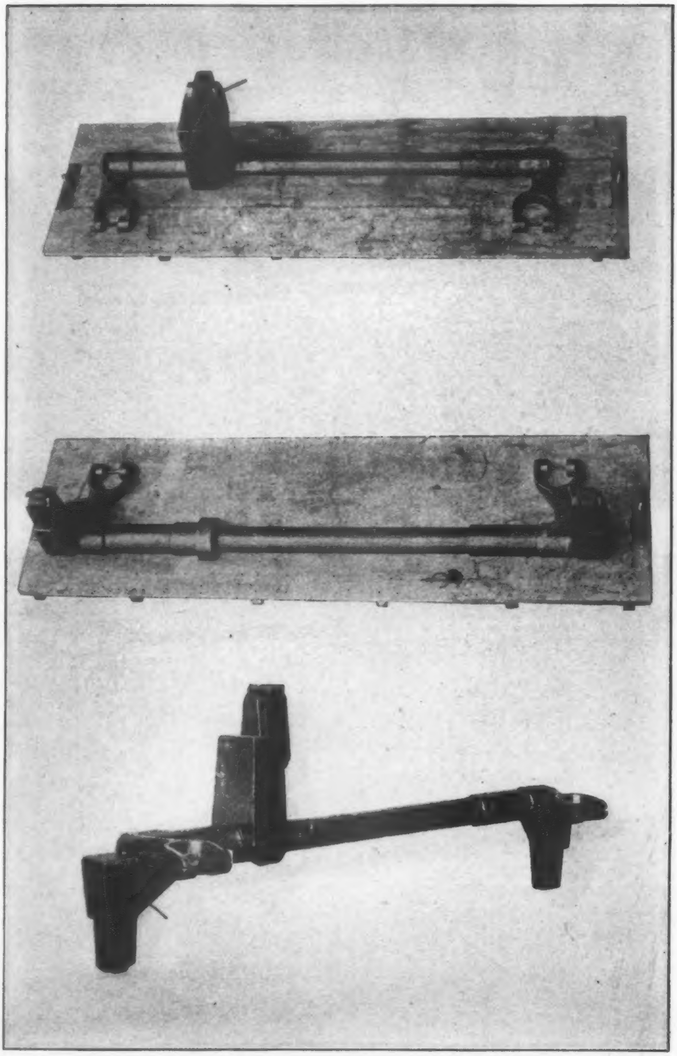


FIG. 15—(Upper Two) INTRICATE SHAPED PATTERNS MOUNTED ON BOARDS FOR MACHINE MOLDING. FIG. 16 (At Bottom) SAME PATTERN BEFORE BEING ARRANGED FOR MACHINE MOLDING—NOTE AWKWARD SHAPE

its cost is less than when made to be used for hand-rammed molding.

I show these views in order that engineers and manufacturers may realize that if all their patterns were made for machine molding the price per pound of castings would doubtless be less, and if patterns were so made, it would give the foundries an opportunity to install molding machine equipment which without the co-operation of the engineers and manufacturers they do not wish to do.

Fig. 17 shows a very difficult molding job for a foundry. The particular design cannot be criticised as this shape is

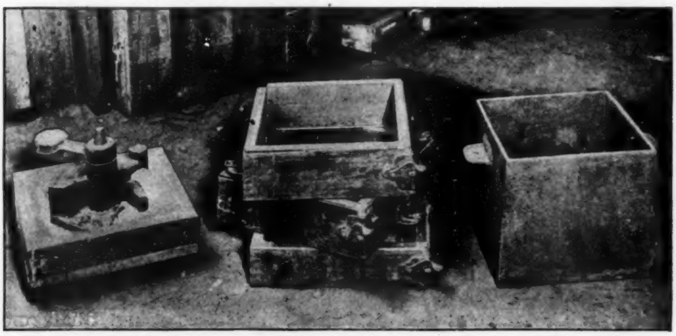


FIG. 17—A PATTERN OF A SHAPE BEST ADAPTED TO FLOOR MOLDING

quite necessary. Therefore, the outfit shown can be used only on the floor in which manner the greatest production can be obtained. This, however, cannot be said of all the engineer's output as many times the foundryman finds his design similar to Fig. 18, in which he has complicated molding by drawing a bracket with round bosses, while the more economical design would be that shown at the top, in which the bosses or loose pieces are eliminated.

Engineer's Understanding of Foundry Operations

Fig. 19 shows the necessity of the engineer understanding foundry operations for if the mold is to be made on the floor by hand, the rib indicated as "loose piece" in the design (shown at the top) should be on an angle in order to eliminate

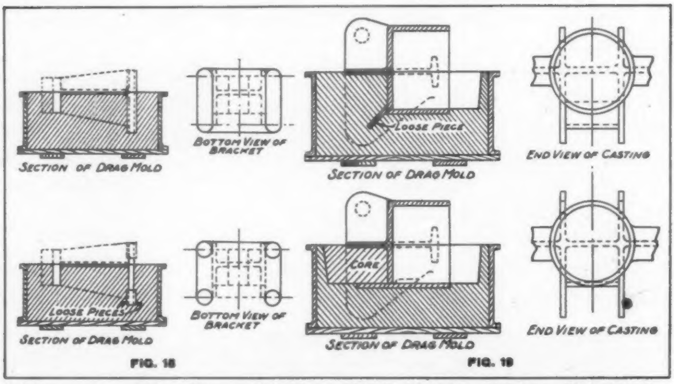


FIG. 18—A BRACKET PATTERN WITH LOOSE PIECES FORMING BOSSES SHOWN AT BOTTOM, WITH THE IMPROVED DESIGN AT THE TOP

FIG. 19—WHY THE ENGINEER SHOULD UNDERSTAND FOUNDRY PRACTICE—NOTE LOOSE PIECE IN MOLD AT TOP

the core as shown on the bottom of the illustration, but if this particular casting was to be made on a molding machine, the horizontal rib is then in order, since when made on a molding machine, the loose rib (shown at the top) would not give satisfaction.

Fig. 20 emphasizes the need of thoroughly analyzing the design in the drafting room before permitting it to pass as final. The casting shown in this view is a hub and flange, such as is used on escort wagon wheels. There were 500,000 of these particular castings to be made and, therefore, the more necessity for eliminating from the design anything that would require additional manpower. For some reason

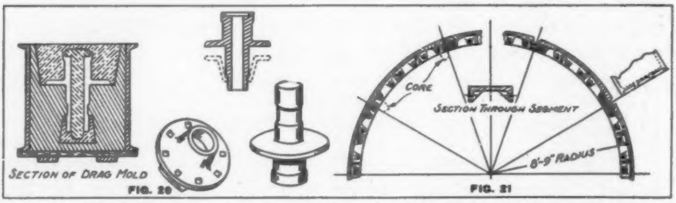


FIG. 20—HUB FOR ESCORT WAGON—AN UNNECESSARILY DIFFICULT DESIGN

FIG. 21—A SIMPLIFIED DESIGN FOR TUNNEL SEGMENT CASTINGS

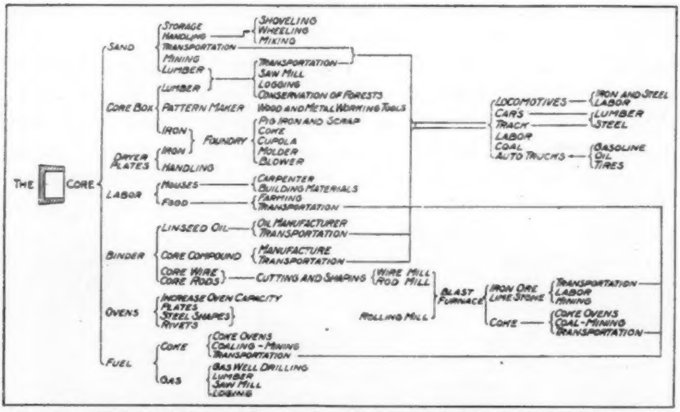


FIG. 22—THE LITTLE CORE FOR ESCORT WAGON HUBS WITH THE TROUBLE IT INVOLVED ANALYZED

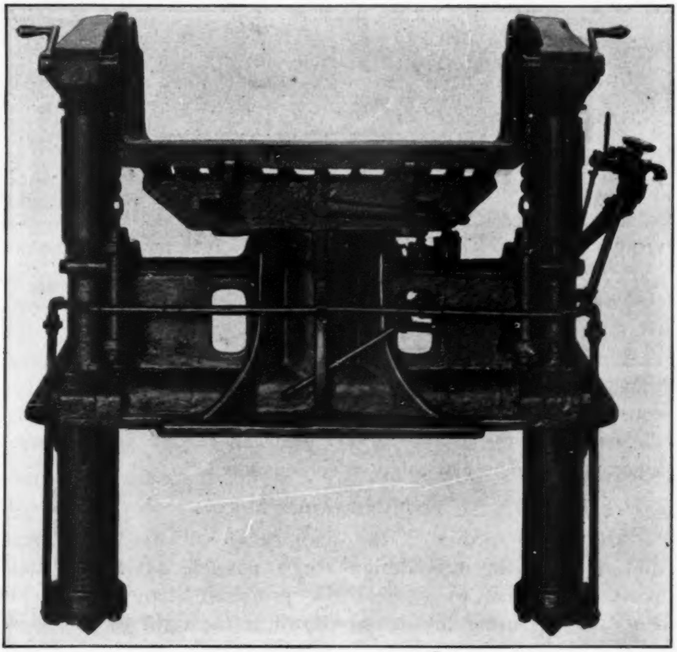


FIG. 23—A MACHINE WITH PARTS CAST SEPARATELY ENTAILING UNNECESSARY MACHINING

or other, you will notice that there is a depression in the stem of the hub and because of this depression, we have a difficult foundry operation. There seems to be no apparent reason for this depression for when made as shown above the picture, there seems to be ample strength and in no way does this change in the design seem to impair its usefulness. The production of this casting with the depression necessitated the ramming core, which is just above the bottom board, in

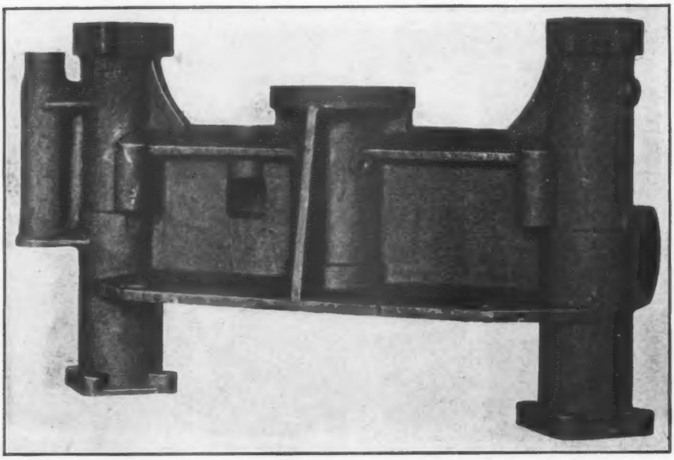


FIG. 24—A CASTING FOR A SIMILAR MACHINE WITH UNNECESSARY MACHINING ELIMINATED

the mold, while the proposed design without the depression, would not require the core.

Fig. 22 shows this core in detail and the many operations involved in its production, and when we stop to consider that to produce this core for the entire quantity, the cost amounts to over $6000, you can readily see the great amount of manpower that was consumed.

Analyzing the Design

Referring to Fig. 2, the quantity of which was so great, and in analyzing this design for a possible saving of manpower, we wish to suggest the proposed change shown in Fig. 22. By using the design shown at the right of this view,

there is eliminated the large core across the end of the mold producing the design shown on the left. The proposed design (at the right) does not at all decrease the strength, nor impair the utility of the casting in any way and yet the saving would have been enormous.

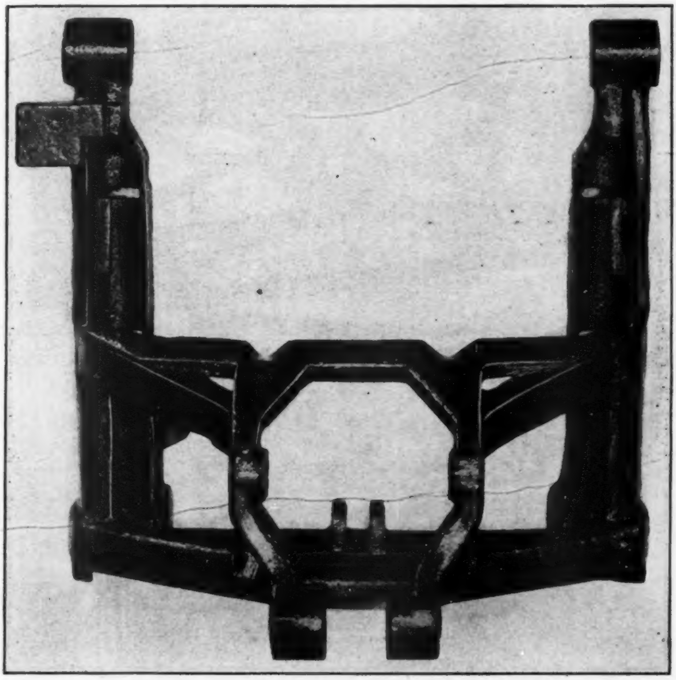


FIG. 25—A CASTING DESIGNED TO ELIMINATE MACHINED JOINTS

In regard to the saving of manpower in the machine shop by a design that will do away with the machining of joints, the views following will show clearly the advantages thus gained. Fig. 23 shows a machine, the base of which is cast separately from the side cylinders, necessitating the machining of the joints and bolting them together with finished bolts in order to secure the rigid construction necessary.

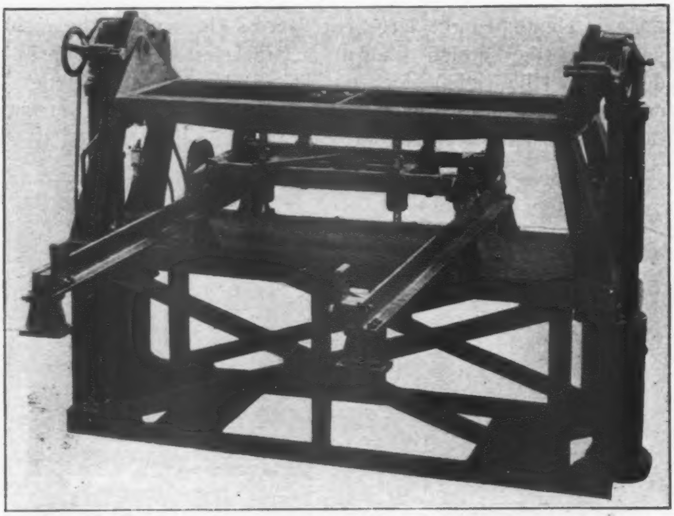


FIG. 26—A MACHINE WITH BASE CONSISTING OF SEVERAL CASTINGS FITTED TOGETHER WITH MACHINED JOINTS

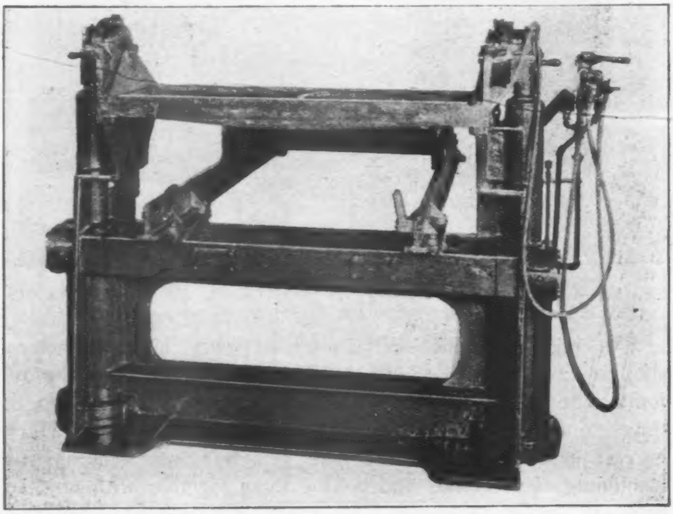


FIG. 27—A SIMILAR MACHINE WITH MACHINED JOINTS ELIMINATED IN THE CASTING

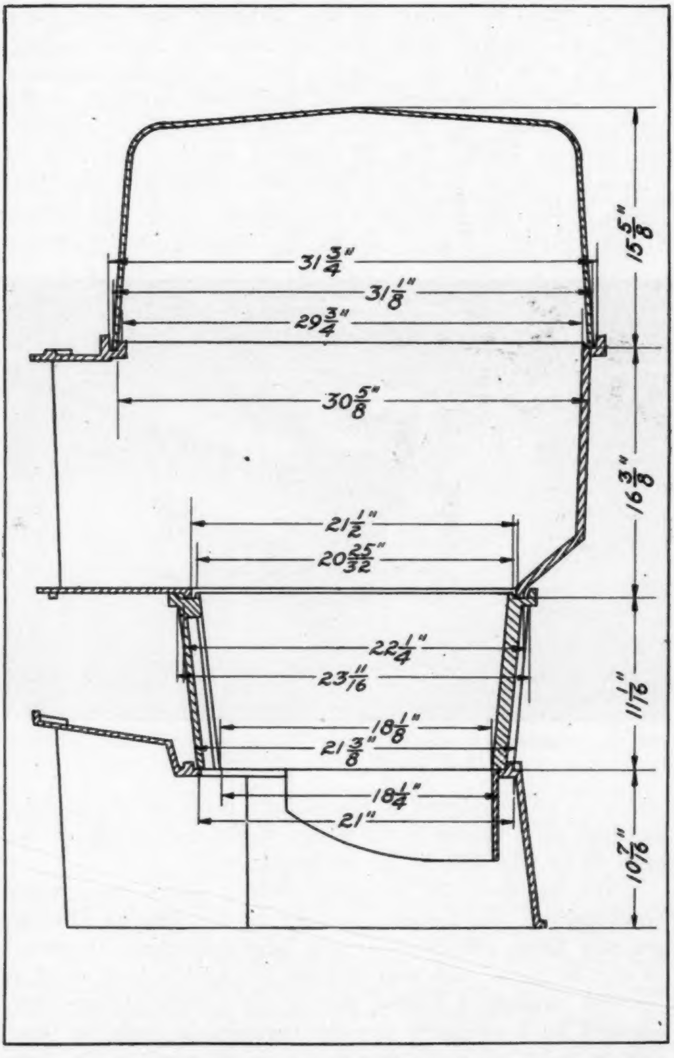


FIG. 28—DESIGN FOR HOUSE FURNACE—CASTINGS MADE ON MOLDING MACHINES

Fig. 14 shows the pattern of this particular base when made to be cast integral, while Fig. 24 shows a similar casting. You will note that the design is such as to eliminate many of the ribs and projections and practically one-half of the machining time. Fig. 25 shows another example of eliminating machine joints. Fig. 26 shows a machine, the base of which is built up of several different castings with machined joints, while Fig. 27 shows these different parts cast integral in the foundry. Fig. 28 shows the ordinary house furnace

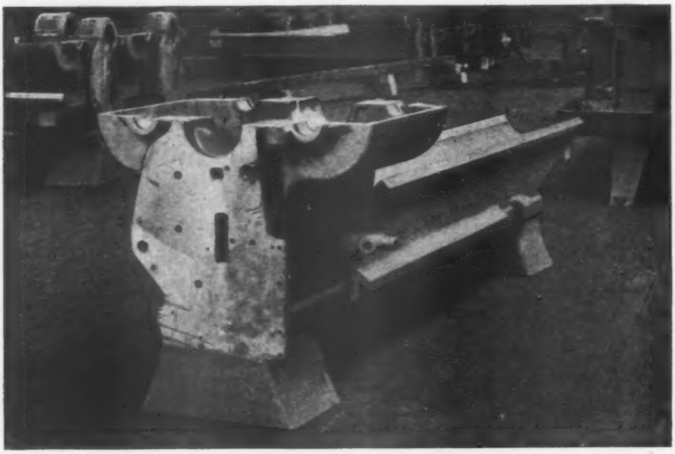


FIG. 29—A MACHINE-TOOL CASTING OF DIFFICULT DESIGN FROM THE FOUNDRYMAN'S STANDPOINT

which as now designed is successfully made on the molding machine, yet a change in the design would very much increase and render less difficult its production.

The machine tool industry perhaps offers the greatest opportunity to the foundry engineer at this time as machines are now being produced in very large quantities. Inasmuch as the design is such that it does not readily lend itself to machine molding, I believe that if the present designs were analyzed by a competent foundry engineer, it would be found that in most all cases they could be changed to do away with some of the present difficulties thereby making possible

an enormously large production by machine molding. Fig. 29 shows a view of a well known machine tool bed. This casting was very difficult to mold because of its many projections and uneven parting lines.

These views are shown in order to suggest to engineers' minds the desirability of analyzing in detail their designs with a view to eliminating manpower in the foundry as well as in the machine shop. They are also shown in the hope that the foundrymen will feel encouraged to bring to the public's attention the desirability of educating its boys to enter this broad field of opportunity.

The Automobile Success

The automobile engineers and foundrymen have been pioneers in co-operating, making possible the production of complicated castings in great quantity at a low cost. Their success is clearly shown by the fact that the automobile is today within reach of most everyone in the country, while in the early days of bolted design, the price was prohibitive.

There are many different machines that are yet to be analyzed and the design changed in order to make the casting a good molding machine operation for the foundry, and the one with which we are doubtless most concerned with today is that of castings used in the shipbuilding industry. Since quantities have become large and the design more nearly uniform or standard, a great opportunity is presented to the engineer and foundryman to co-operate, making ship castings by machine molding with its consequent saving of manpower. Referring to tables I and II, an investigation of some of the castings used in this industry shows the enormous gain in manpower possible by the installation and use of the rollover molding machine, even though the quantities are not as large as heretofore required by the specialty foundries.

Many of the ship casting patterns readily lend themselves to mounting on pattern plates, thereby making possible machine molding, while in other cases it is necessary to design the original pattern to be molded on a machine, and in a few instances designs can be profitably changed to eliminate some of the molding complications.

Table I

Memorandum of Saving in Ship Castings

—Castings required—		Machine molding					—Hand molding—				—Saving—		
Name	Quan.	Mch.	A	B	C	Cost, ea.	A da.	B da.	C	Cost, ea.	Val.	%	Man days
A—Low pressure.. Cyl.–45-in. bore.	24	407	4	4	6	5.25	1–3	2–3	72	31.50	$630	83	120
A—Int. Cyl. ..... 24-in. bore.	24	407	4	4	6	5.25	1–5	2–5	120	52.50	1134	90	216
B—High pressure.. Cyl.–20-in. bore.	24	407	5	4	5	4.20	1–1½	2–1½	36	15.75	277	73	52
C—Housing	72	407	15	4	5	1.40	1	2	72	10.50	655	87	124
D—Propeller	24	407	4	3	6	4.13	1	2	24	10.50	153	60	30
E—Steering ...... Eng. Cyl.	24	406	20	3	1	.83	1	2	24	10.50	232	92	47
E—Vent. Gear....	72	406 or 407	20	4	4	1.05	1	2	72	10.50	680	90	56
Total	..	...	.	26	.	....	...	14	..	.....	$3761	..	645

Total saving, $15,000 per month

Average percentage of saving, 85 per cent

A—Output. B—Men. C—Time.

Table II

Memorandum of Saving in Ship Castings

Castings required		—Machine molding—					—Hand molding—				—Saving—		
Name	Quan.	Mch.	Output	Men	Time	Cost, ea.	Output	Men	Time	Cost, each	Value	%	Men days
22-in. Bits—C..	600	406 2 bxs.	30	4	20	.70	2	2	300	5.25	$2730	86	520
Core	2400	404	140	2	17	.086	16	1	150	.375	693	77	116
Total	....	...	...	6	..	....	..	3	...	....	$3423	..	636
9-in. Bits—B...	1800	406 2 bxs.	35	4	52	.60	3	2	600	3.50	$5220	83	992
Core	7200	404	140	2	52	.086	36	2	200	.33⅓	1780	74	296
Total	....	...	...	6	..	....	..	4	...	....	$7000	..	1288
6-in. Bit—A....	600	405	40	3	15	.413	6	2	100	1.75	$802	76	155
Core	1200	403	150	1	8	.04	25	1	48	.24	240	83	40
Total	....	...	...	4	..	....	..	3	...	....	$1042	..	195
Mooring rings													
Dwg. H-52–No. D	1200	405	40	4	38	.525	9	6	167	3.50	$4462	85	850
No. E	300	...	...	.	..	....	..	.	...	....	....	..	...
Core No. D....	2400	403	100	2	30	.12	18	1	167	.33	630	63	107
No. E....	600	...	...	.	..	....	..	.	...	....	....	..	...
Total	....	...	...	6	..	....	..	7	...	....	$5092	..	957

Total saving, $16,557.00

Total amount labor by hand molding (Man Days)............	3,767
Total amount labor by machine molding (Man Days).........	691
Saving in labor Man Days................................	3,076

Average percentage of saving, 81 per cent

Discussion—Engineers, Their Relation to the Foundry

The President, B. D. Fuller.—There is one point that Mr. Carman brought out very vividly which struck me as being worthy of a few words, and that is in connection with patterns, putting them on the boards originally, instead of building solid patterns. I believe there was not enough said about that, for that does effect a very great saving, whether you are going to put it on the molding machine or not. You will get better production at lower cost.

As he pointed out in one instance, if you put it on that board and apply it to a molding machine, it will require a core. Take that same pattern and put it on the board, as he pointed out, and lift that core out and mold it with hand, and you have got your solid pattern on the board. When you draw your board, you draw your pattern.

Mr. McKeefrey.—Some of the questions that have been suggested by Mr. Carman's paper are extremely interesting, from my viewpoint. I think that you can go to extremes in all of these things. The suggestion that you have to get the designing engineer to know definitely in advance just where the casting is going to be made, is one that cannot always be predetermined; and the number of castings which have to be made is a very decided factor. Now, it is possible that a pattern may be made at one time, for one purpose, and used. For purposes of economy and saving men in the drafting room and in the casting shop, two more castings would be made of that pattern again. Now, those things are bound to occur. I have in mind Mr. Carman's suggestion of care in the analysis of the design, where quantitative production is desired, and that is absolutely fundamental at this time.

There are a great many small plants scattered all over the the country, whose requirements are for one piece at a time;

and there is still going to be room for a large improvement in that work.

I think Mr. Carman's suggestion of the mounted pattern applies very generally, even to those concerns, because of the difficulty in obtaining skilled labor. I do not think very many of us realize to the full our responsibility in the saving of man-power. But I, for one, am not willing to take the time of a draftsman and his chief and two or three other men to go over a small matter which may mean an hour in the foundry. And it may not. Of course, if the same thing means an hour over again a thousand times, then the thing is justified, to go over it again. But the thing that is being well done sometimes can be continued along that line.

I have learned a good deal from Mr. Carman's suggestion, and I think we ought to give perhaps more attention to the designing of intricate work in solid pieces, rather than try to machine a whole lot of pieces and put them together, because the machine hands are just as scarce as molders, and just as hard to get at the present time. Likewise machines, themselves, are very difficult of obtaining. All of these things have to be considered.

But there is much of interest in what Mr. Carman has presented to us bearing upon many points, where intricate production is required; and you cannot give too much attention to the initial design of a thing that is going to be made over and over again.

In the particular instance to which Mr. Carman called attention, the undercut on the casting, personally I believe that that was made for tool clearance. In my shops it would be impossible to machine it without tool clearance. Of course, there are modern tools on which it could be done without tool clearance; but I do not think that there is any question but what the criticism Mr. Carman referred to of the design was justifiable in this instance, because he said there was an order of 600,000 to be made. Quantity production of that kind is entitled to different consideration than that which can be given where it is to be used a half dozen times.

Dr. Robert Grimshaw.—Mr. Chairman, it is one fault, I think, of our modern machine shops that the draftsmen are

not obliged to take their rough sketches, first, to the pattern shop, second to the coreroom, and third to the foreman of the molding room, to see what they have on them. I was compelled to do it when a cub in the ship works. In most establishments it is not the case. I happen to know of a very large works, the Krupp establishment in Essen, Germany, where no head of any department is permitted to visit other departments. This is very bad practice. They are afraid that some one man will learn how to do all the work, and go over to the opposition. That is why the Skoda Works in Pilsen, Austria-Hungary, are doing better work than Krupp ever did. In some establishments the draftsman makes a rough sketch on the blackboard, full size, and they call in the patternmaker and the coremaker, and the foreman of the molding floor, and the draftsman gets some new ideas, and some of the conceit is taken out of him.

The Cottrell Precipitation Process and Its Application to Foundry Dust Problems

By H. D. Egbert, New York.

In copper, lead and zinc smelters and refineries and in chemical works, the Cottrell electrical precipitation processes have been recognized for several years and are well established as a standard means for removing finely divided particles of material such as dust, fume, acid mists, etc., from gases. It is only more recently, however, that the use of these processes has been seriously considered as applied to the solution of the dust problems which are present in nearly every manufacturing establishment where grinding, buffing, polishing, sand-blasting or metal cleaning form a part of the operations.

The dust-handling problems connected with sand-blasting and tumbling-barrel operations in iron foundries have long presented many points of difficulty, and it is therefore but natural that interest should have been aroused in the possible application of electrical precipitation to their solution. Already considerable thought has been given and much work done toward adapting the Cottrell processes to this particular field and the results to date are most promising. This paper proposes to deal with the Cottrell processes, with particular reference to their application to foundry dust problems. A description will be given of a typical installation designed to clean the dusty air coming from tumbling barrels in an iron foundry.

Before proceeding, however, to a discussion of what has been done in this particular field with the Cottrell processes, a brief explanation of the fundamental principles underlying

the electrical precipitation processes will undoubtedly be of interest and will further serve to make clear the terms used in the descriptions given in this paper.

Principles of Electrical Precipitation

A body highly charged with electricity and so shaped as to facilitate the silent discharge through the surrounding air of some of the electrical energy with which it is supplied, will impart an electric charge of the same sign (i. e., negative or positive as the case may be) to any particles of matter which may be in its immediate vicinity. As bodies charged with electricity of the same sign repel each other, all such particles will, if free to move, be violently repelled from the fixed charged body to which the electrical energy is being supplied. This is exactly the principle made use of in electrical precipitation.

The essential elements of a precipitator are two sets of electrodes. One set, known as the discharge electrodes, are of such form as to facilitate an electric discharge from their surface, as for instance a wire or a light chain or a strip of metal having relatively sharp edges, while the other set, known as the collecting electrodes, are of such shape as to prevent as far as possible any discharge from their surfaces, as for instance a flat plate or a pipe with a smooth interior surface.

These electrodes are so arranged in the precipitator that the different types oppose each other and between them a silent or glow discharge is maintained by supplying to the discharge electrode electrical energy of a unidirectional character and at a relatively high voltage. In practice the collecting electrodes are grounded for reasons of convenience and safety, the ground being used as the return portion of the circuit. A typical form of precipitator, for example, consists of a grounded pipe along the central axis of which is suspended a wire connected to a source of unidirectional high voltage electric power.

How the Dust is Collected

The air or other gas carrying the suspended liquid or solid particles which are to be removed is passed between the discharge and collecting electrodes. During passage the particles

of suspended matter are charged and are driven away from the discharge electrode and over to the collecting electrode, upon which they are deposited. The air or other gases are unaffected and pass on out of the precipitating chamber.

It will be evident on slight reflection why high potential alternating current is not used to produce the precipitating effect. This is due to the fact that in such cases the charge on the electrodes rapidly alternates in sign and the particles of matter are alternately repelled and attracted by the discharge electrode and consequently tend to remain suspended in the gas. Alternating current does have an agglomerating effect on the particles, which is particularly noticeable when these particles are liquid in their nature.

If the interior of the precipitator is darkened a glow will be observed emanating from the discharge electrodes, while they are connected to the source of high voltage electrical power.

This glow is known as the corona and is an evidence of the intense ionization of the air or other gases surrounding the electrode. For any given gas there is in all cases a rather definite voltage at which a visible corona begins to form depending upon the character of the discharge electrode and the distance or gap space between it and the collecting electrode. The shorter the distance between the electrodes and the smaller the wire or chain used as a discharge electrode, the lower the voltage at which a visible corona will begin to form.

It has been found that the most effective precipitating action is obtained when the potential difference between the electrodes is sufficient to produce a corona discharge and when the discharge electrode is charged negatively rather than positively. The difference in the appearance of the corona when the discharge electrode wire is positively charged and when it is negatively charged is quite marked and when once observed is always easily recognizable. When the wire is positive the corona is seen as a more or less uniform and intense purple glow surrounding the wire. When negative the corona appears as a series of brilliant points of purplish light spaced at rather regular intervals along the wire.

In connection with the references which have been made to the corona phenomena observed in electrical precipitators, it is interesting to note that the corona discharge which is so useful in precipitation work is exactly what the high tension transmission line engineer endeavors in every way to prevent, because to him it represents a distinct loss of power, whereas in the precipitator it is this very power or electrical energy emanating from the discharge electrode which makes possible the precipitation of the suspended particles.

Voltage Used Varies

The voltage employed in a given precipitator depends upon the size and type of discharge electrode used, the gap distance between the discharge and collecting electrodes and the temperature and other characteristics of the gas being treated. There is a definite relation between the velocity of the gases through the precipitator and the length of the path between the electrodes, in other words the particles must be under the influence of the electric field for a suitable period of time in order to secure satisfactory removal of these particles from the gases The length of this period depends to a considerable extent upon the character of the particles to be precipitated. If the particles are fluffy in character, light, dry and very finely divided a longer time will be required than if they are relatively heavy or coarse or of a liquid or sticky nature. The length or height of the precipitator is, of course, limited by considerations of practicability and cost and consequently there is in every case a definite limit to the gas velocity through the precipitator at which complete removal of the suspended particles can be accomplished.

Size of Collecting Pipes

In practice it is common to use collecting electrode pipes ranging from 6 to 12 inches in diameter and from 6 to 15 feet in length, and gas velocities ranging from 6 to 15 feet per second, depending upon the factors just mentioned. It is usual to construct the precipitation installation in sections or units. Such an arrangement may cost somewhat more than a single unit or section, but it has the advantage of allowing considerable flexibility in the operation of the precipitator and permits

of a closing down of a portion of the installation for repairs or cleaning without involving the removal of the entire precipitator from service. When the volume of air or gas to be treated is liable to vary at different periods of time this sectional arrangement of the installation has the further advantage of permitting a saving in power by shutting down certain sections of the precipitator at those times when the maximum gas volume does not have to be cleaned.

If the collected material is liquid in nature it will, of course, trickle down the surface of the collecting electrodes and will drop into a suitable container provided for the purpose beneath the precipitator. In such cases the precipitator is self-cleansing. If the collected material is dry or at all sticky in nature it is often necessary to dislodge it from the electrodes by mechanical means. Usually the cleaning is accomplished by striking or rapping the pipes or plates whereupon the collected material falls into hoppers placed beneath the precipitator to receive it. In some cases it is also necessary to clean the discharge electrodes occasionally, and when such a condition is anticipated provision is also made for rapping the framework which supports the high tension or discharge electrodes.

The power consumption of an electrical precipitator is governed by the number of electrodes and their length, type and size, as well as by the characteristics of the gases to be cleaned as regards temperature, conductivity, etc. The power consumption, however, is in no cases excessive and is usually quite small. For example, a precipitator for cleaning 10,000 cubic feet of gas or air per minute will usually require no more than 7 to 10 kilowatts.

How the Current is Generated

A short description of the method commonly used to obtain the high potential unidirectional current required by the precipitator will doubtless be of interest. This equipment is, of course, more or less special in its nature and is particularly designed for use in precipitation work. Care must be taken in each case to choose equipment of the proper size and type for each particular installation.

If low tension alternating current of any commercial frequency is available at the plant in which the precipitator is installed, all that is required in the way of electrical equipment

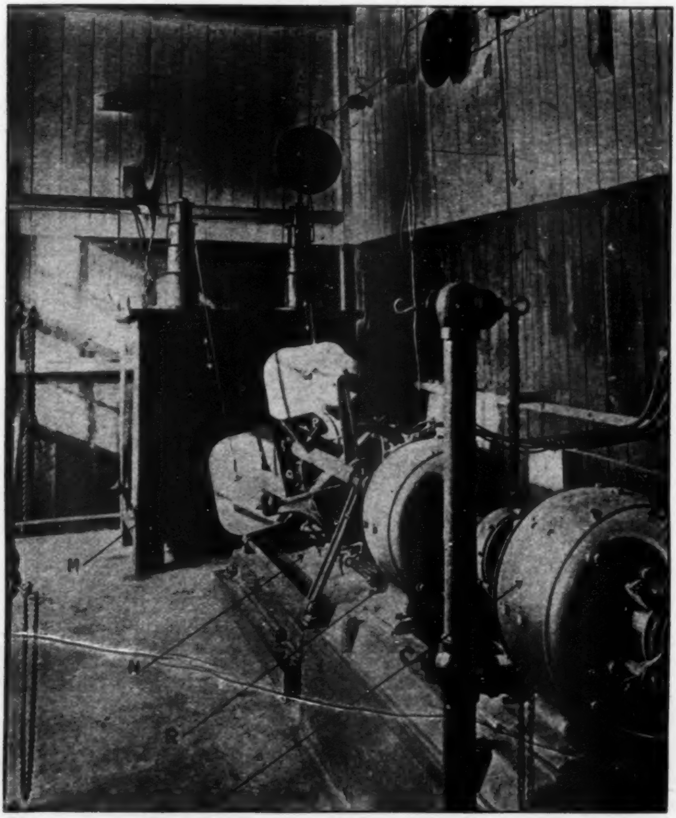


FIG. 1—SET OF ELECTRICAL EQUIPMENT FOR USE WITH COTTRELL PRECIPITATION INSTALLATION

is a transformer of proper capacity for stepping up the low tension electric current to the required voltage for use in the precipitator; a rectifier for changing the high voltage alternating current into high voltage unidirectional current, and a small

switchboard panel with the necessary instruments, circuit breaker, rheostat, etc., mounted upon it. A 2 to 3-horsepower synchronous motor is also required for driving the rectifier in synchronism with the alternating current supply.

If only direct current is available at the plant in question it is necessary to install a small motor-generator set for the purpose of producing the low tension alternating current. The

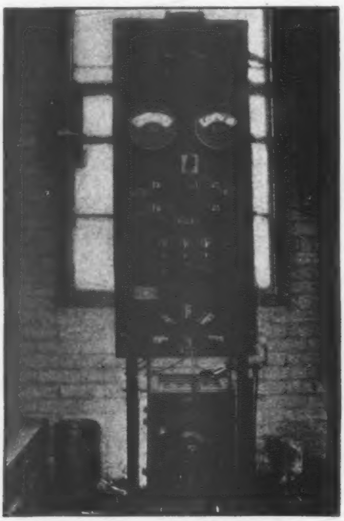


FIG. 2—SINGLE-PANEL SWITCHBOARD FOR USE WITH COTTRELL PRECIPITATION INSTALLATION

remainder of the equipment is the same as in the previous case, with the exception that the rectifier instead of being provided with a separate synchronous driving motor is driven by the motor-generator set and directly connected to it by means of a flexible coupling. During the last year or two a high-potential direct-current generator known as the Girvin generator has been successfully used for precipitation work. This generator, by furnishing direct high voltage current does away with the necessity for a transformer or rectifier and thus

combines in a single machine the functions performed by the low tension generator, transformer and rectifier previously described. The Girvin high-voltage generator can be belt

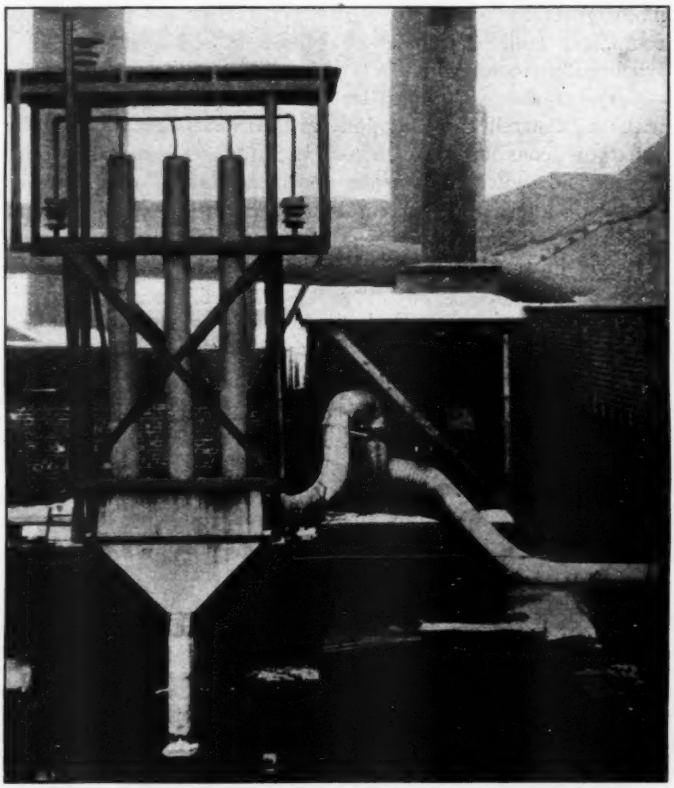


FIG. 3—TEST COTTRELL PRECIPITATOR TREATING AIR DRAWN FROM FOUNDRY TUMBLING BARRELS

driven by a separate motor operating from the plant power line or it can be furnished as a motor-generator set, in which case the driving motor is mounted in the frame of the machine and forms an integral part of the apparatus.

The cost of the electrical equipment is, of course, dependent upon the size of the precipitator which it is to supply and it is also dependent to a certain extent upon the power available at the plant where the installation is to be made. If a motor-generator set is to be used the cost of the electrical equipment will, of course, be considerably higher than if a synchronous motor could be employed.

Fig. 1 shows a typical set of electrical equipment for use with a Cottrell precipitation installation. This particular apparatus consists of a motor-generator set, rectifier, transformer and switchboard panel. As mentioned, in case a steady supply of alternating current is available at the plant a small synchronous motor can be substituted for the motor-generator set here shown, thus reducing considerably the cost of the electrical equipment.

Fig. 2 shows a typical single-panel switchboard for use with a single set of electrical equipment such as is employed with a moderate sized installation of the Cottrell processes. At the top of the switchboard will be seen a circuit breaker which operates to disconnect the synchronous motor if short circuits occur anywhere in the precipitator or in other portions of the high tension or low tension circuits. Beneath the circuit breaker will be seen the ammeter and voltmeter which are connected in the low tension circuit of the transformer. Below these meters is a switch, also in the low tension circuit to the transformer, which permits disconnecting the primary windings of the transformer from the power supply circuit. Below this switch on the board is a multiple-point switch which connects the various taps brought out on the primary or low tension side of the transformer. By changing the position of this switch the secondary voltage delivered by the transformer may be varied at will within certain fixed limits.

Tests in a Foundry

Several months ago an exhaustive series of tests were made with the Cottrell processes on dust laden air drawn from tumbling barrels in a large iron foundry near New York City. These tests demonstrated that an electrical precipitator could successfully remove and collect all the dust carried by the

air from these tumbling barrels under various conditions of operation.

Fig. 3 is an illustration of the precipitator which was installed in connection with these tests. The collecting electrodes consist of three sheet-iron pipes 12 inches in diameter and 12 feet long erected on a bottom header box provided with a hopper and spout for the removal of the collected

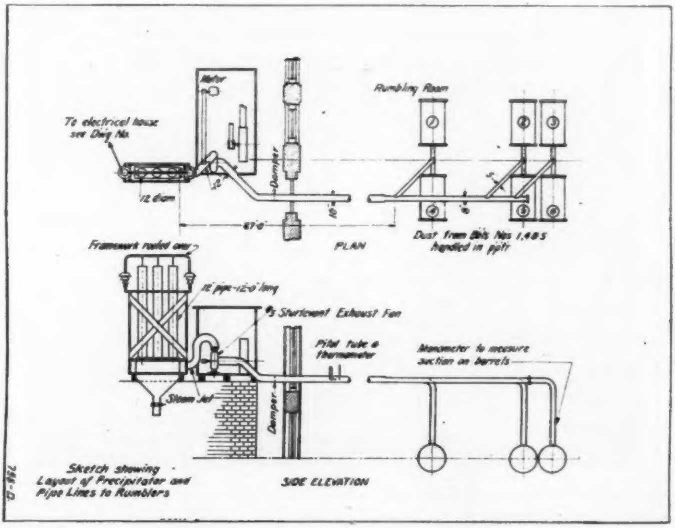


FIG. 4—ARRANGEMENT OF TEST COTTRELL INSTALLATION TO TREAT AIR FROM FOUNDRY TUMBLING BARRELS

material. For discharge electrodes, No. 10 jack chain was used suspended along the vertical axis of each pipe. The dust laden air was drawn from the tumbling barrels used in the tests by means of a motor driven centrifugal fan located near the precipitator, as shown in the illustration.

It was found that this precipitator could clean the air drawn from three tumbling barrels, the fan being operated so as to maintain a suction head of 2¾ to 3 inches on each barrel. For the particular conditions met with at the plant in question this suction head on the tumbling barrels seemed to

give best results both as regards the time required for tumbling and the satisfactory cleaning of the castings. The volume of air handled by the test precipitator under these conditions averaged about 1100 cubic feet per minute at a temperature of 63 degrees Fahr. so that each pipe was cleaning approximately 366 cubic feet of air per minute.

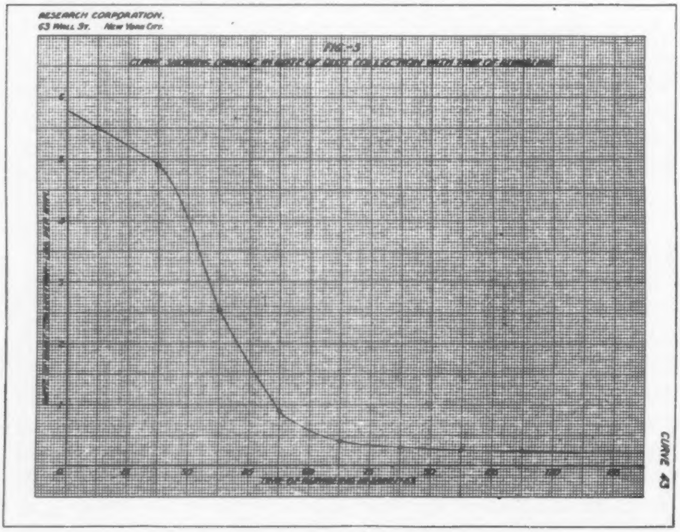


FIG. 5—CURVE SHOWING CHANGE IN RATE OF DUST COLLECTION WITH TIME OF RUMBLING

Fig. 4 gives in plan and section a diagrammatic layout of the test precipitator and its connections to the tumbling barrels.

Tests of Dust Flow

During the tests measurements were made to show the amount of dust coming from the barrels at various times in the cycle of operation. It is interesting to note that practically 65 per cent of the dust was caught in the first half hour following the starting up of the tumbling barrels on a new batch of castings. Thereafter the amount of dust carried in suspension in the gas dropped off very rapidly until after one hour the

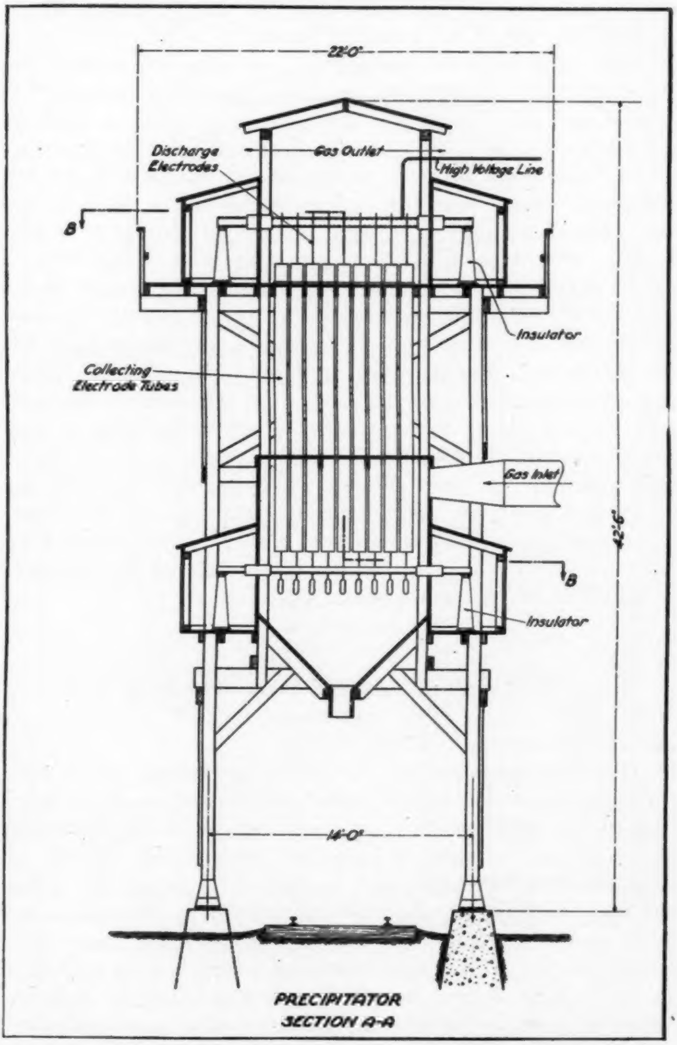


FIG. 6—VERTICAL SECTION THROUGH COTTRELL PRECIPITATOR DESIGNED TO CLEAN AIR FROM FOUNDRY TUMBLING BARRELS

dust content became practically constant and remained nearly so until the end of the tumbling period.

Fig. 5 is a curve obtained by averaging the results for three separate runs with the test precipitator and showing the rate of dust fall. Of course, with a larger precipitator cleaning the dusty air from a large number of tumbling barrels, the rate of dust fall would be much more uniform than was shown by the results of the tests just described, due to the fact that in the normal operation of a large number of barrels it is not common to charge them all at the same time. Thus certain of the barrels will be commencing the tumbling period while others are approaching the end of this period and as a consequence the dust content of the combined air drawn from all the barrels will be more nearly uniform. Naturally the operation of a precipitation installation is most satisfactory when the dust content of the gases is fairly uniform and thus it was considered that the operating conditions under which the tests were run were the most difficult which might be expected to occur, and since the precipitator operated successfully under these conditions equally satisfactory results with a larger precipitator handling the air from a larger number of tumbling barrels was felt to be assured.

A Larger Installation

Based on the results obtained from these tests a precipitation installation to clean approximately 22,000 cubic feet of gas per minute has been designed.

Fig. 6 is a vertical section of this precipitator, while Fig. 7 shows a horizontal section. The precipitator, as will be seen, consists of three sections or units, each with 36 collecting electrode pipes or tubes 8 inches in diameter and 15 feet in height. The recent tendency in electrical precipitation work has been toward collecting electrode tubes of smaller diameter, as it has been found that with the smaller pipes somewhat better efficiency with a lower operating voltage can be obtained. In the present design, therefore, collecting electrode tubes 8 inches in diameter rather than 12 inches have been employed, and the operating voltage will be approximately 65,000 to 70,000 volts.

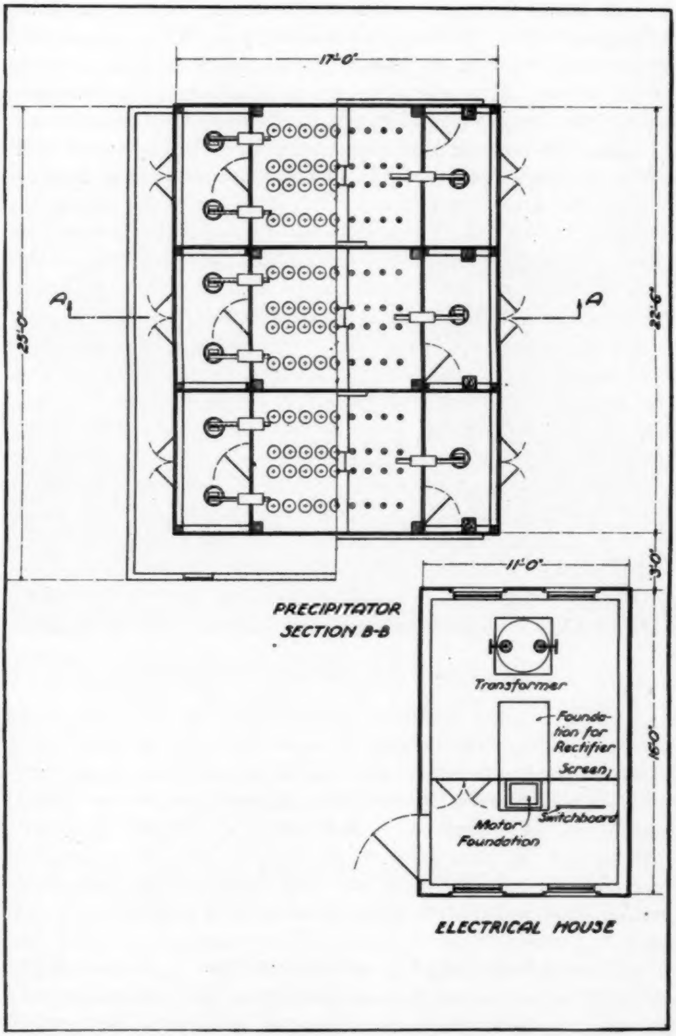


FIG. 7—HORIZONTAL SECTION THROUGH COTTRELL PRECIPITATOR DESIGNED TO CLEAN AIR FROM FOUNDRY TUMBLING BARRELS

In order to secure uniform distribution of the dusty air among the several collecting electrode pipes, the air is admitted some distance above the bottom of the pipes so that it passes down around these and then up between the electrodes and so into the top header, whence it is discharged to the open air.

The collecting electrode pipes are of No. 16 gage sheet steel while the supporting structure as well as the bottom and top headers and hoppers are timber. One set of electrical equipment is provided to furnish the current for all three precipitator sections. This set, which is to operate on a 440-volt, 3-phase, 60-cycle power line will consist of a 25-kilovolt-ampere transformer having a maximum secondary voltage of 75,000 volts; a mechanical rectifier driven by a 3-horsepower, 3-phase, 1800 revolutions per minute synchronous motor, a switchboard with the necessary instruments, circuit breaker, rheostat, switches, etc. It is estimated that the entire installation as shown, exclusive of any engineering or license fee, will cost in the neighborhood of $11,000, exclusive of the cost of any flue connections from the exhauster to the precipitator. Although not shown on the drawing, means will be provided for rapping both the collecting and discharge electrodes so that should it be necessary the collected material can be in this way shaken down from the electrode surfaces.

Arrangement of Rapping Hammers

These rapping hammers or knockers can be arranged to operate automatically through a motor-driven mechanism, or as is more usually the case, they can be operated by hand, especially if the intervals between the rapping periods are not too short. In the design as shown, space is allowed so that a railway car can pass beneath the hoppers for the purpose of receiving the collected material. The height of the precipitator can be decreased considerably if such arrangement is not necessary.

It is always desirable to have the house containing the electrical equipment as near as possible to the precipitator so as to make the high tension line from the rectifier to the precipitator as short as possible. As explained previously, ground is used as the return portion of the circuit so that only one high-

tension wire is actually used. This should be protected by surrounding it with a grounded wire mesh screen which will prevent anyone from coming accidently in contact with the high-voltage current.

Switches can be provided in the high voltage line so that any section of the precipitator can be disconnected from the line at will. Dampers should be provided in the inlet flue

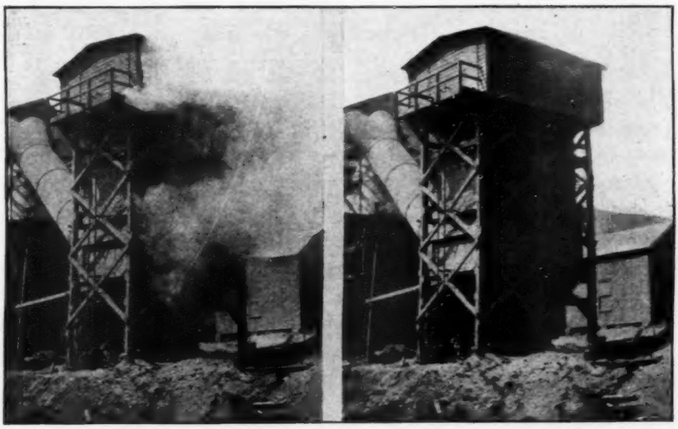


FIG. 8—COTTRELL PRECIPITATOR TREATING AIR FROM SLATE ROCK CRUSHERS—CURRENT OFF. FIG. 9—COTTRELL PRECIPITATOR TREATING AIR FROM SLATE ROCK CRUSHERS—CURRENT ON

to each precipitator section so that the air can be also cut off from any particular section, should it be desired to shut down any such section for inspection or repairs.

The Winchester Installation

A Cottrell precipitation installation has been in operation for the last two years at the plant of the Winchester Repeating Arms Co., New Haven, Conn. About 50,000 cubic feet of air per minute at a temperature of approximately 70 degrees Fahr. is cleaned. This air is drawn from buffing and grinding wheels and brazing pots, and the precipitator in which it is cleaned contains 200 collecting electrode tubes or pipes of sheet

steel 12 inches in diameter and 12 feet long. The collecting electrodes are heavy iron wires suspended along the longitudinal axis of the pipes and weighted at the bottom to hold them taut. The power consumed by this installation is approximately 18 kilowatts and it is furnished by one set of electrical equipment consisting of a transformer, synchronous motor, rectifier and switchboard panel. In this case the supporting structure and top and bottom headers of the precipitator are entirely of steel and the electrical equipment is housed in a small building adjacent to the precipitator and carried on the same supporting platform.

Figs. 8 and 9 illustrate graphically what the Cottrell processes can accomplish in the way of dust collection. The precipitator shown handles air drawn from slate rock grinders or crushers at a plant in Vermont. Fig. 8 shows the precipitator with the electric current turned off, while Fig. 9 shows the same precipitator after the current has been turned on. The heavy dust content of the air which the precipitator is obliged to clean is well shown by the clouds of dust coming out of the top header of the precipitator in Fig. 8, when the installation is not in operation, and the effective cleaning of the air is clearly shown by Fig. 9. This precipitator handles some 35,000 cubic feet of gas per minute, and has been in continuous operation for nearly three years. This installation has recently been enlarged and will shortly be handling a total of nearly 100,000 cubic feet of air per minute. As will be seen from the illustrations, the collecting electrodes and hoppers in this precipitator are made of sheet steel, while the supporting structure and top header are of timber.

Fire Risk Reduced

For the Cottrell processes of electrical precipitation several advantages are claimed which make them particularly adaptable for dust cleaning work in factories and foundries. In the first place, the dust can be collected satisfactorily, no matter in how finely a divided state it may be. Secondly, the danger of fire can be eliminated, since the precipitator can, if so desired, be built entirely of sheet metal. Likewise the

gases can be treated at any temperature up to 1000 degrees Fahr.

Inasmuch as the precipitator offers but little obstruction to the air or other gases passing through it, the fan power required for passing the gases through the precipitator is small and this alone is an important feature when cost of operation is considered. The labor required in operating an installation is small, consisting chiefly of that necessary to occasionally shake the electrodes and remove from the hoppers the collected material. Of course, if it is desired, conveyors can be provided in the hoppers beneath the precipitator so that the material can be removed automatically. The electrical equipment can readily be looked after by the plant electrician and is designed to require little beside the ordinary oiling and cleaning to keep it in satisfactory operation. It should, if possible, be housed in a separate small building placed near the precipitator. This building should be kept locked and no one but the electrician or operator charged with the care of the machinery should be allowed to enter it.

Inasmuch as questions are often asked regarding the ownership of the electrical precipitation processes, it may be stated that the Research Corp., New York, owns and controls the patent rights to these processes throughout the United States with the exception of the six western states of Washington, Oregon, California, Idaho, Nevada and Arizona and with the exception of the application of these processes in the Portland cement factories throughout the country. The rights to the Cottrell electrical precipitation processes in the six western states named and in Portland cement factories throughout the country are owned and controlled by the Western Precipitation Co., Los Angeles, Cal.

The use of the Cottrell processes in connection with foundry dust problems is only one of the many possible applications of these processes and wherever problems are met with involving the removal from gases and air of dust, fumes or acid mists, electrical precipitation invites consideration.

Sale and Distribution of Foundry Pig Iron in War Times

By C. J. STARK, Cleveland, Ohio

War has put normal foundry business in the discard. No major section of the iron and steel industry has been so extensively dislocated by the transition of the United States from a peaceful to an aggressively belligerent nation, as the casting industry, particularly in its chief branch, gray iron. It would be difficult throughout the length and breadth of the country today to find many shops which are turning out work they were originally built or designed to do; or were doing a little more than a year ago.

The steel mills are producing shell rounds and shell billets by the millions of tons. They are yielding plates at the annual rate of 6,000,000 tons, whereas before the war their best record was approximately 3,700,000 tons yearly. They are rolling other lines of finished material at a tonnage rate far different, both less and greater, from that shown in previous years or under ordinary business conditions. This has been brought about primarily by an altered division of raw steel supply and secondarily by the building of some new mill and steel works capacity. From those mills finishing products for which the demand has been less insistent, ingot tonnage has been diverted to other units capable of producing material called for by the most vital purposes. This largely has been a process of adjustment and of accommodation to a new line-up of demand. It has been facilitated by the virtually permanent condition in the steel industry of an excess of finishing mill capacity over steel works output; likewise by the range of operations possible on certain types of mills. Thus, the rail and structural shape mills as well as the merchant bar mills have been turned to the rolling of large rounds for projectiles; and much of that

steel which ordinarily would have gone into rods for wire products, into sheet bars for sheets and into small billets for merchant bars, or other finished products, has been put into slabs for plates, into large billets for shells or into some form to suit the particular requirements of war. It has been a question of speeding up the production of this or that product to the utmost point which has been made possible by a maximum and continuous supply of raw steel; and contrariwise by putting the brakes on the output of other mill material less essential from a tonnage standpoint. This on the whole, has involved no radical departure from standard practice; or from the line of manufacture for which the respective plants were established originally. War demands plates, rails, sheets, wire, structural shapes, bars, tin plate and virtually all finished steel lines, as well as peace, though in different proportions.

Complex Situation Confronts Foundrymen

With the foundries, however, it has been an entirely different situation. Modern war does not require castings to the extent or in the form demanded by the pursuits of peace. Furthermore by its intense absorption of such basic materials of production as pig iron, scrap, coke, coal, etc., it imposes restraints upon everyday civil life and cuts down normal consumption. The result is a surplus of foundry capacity which if it is to be maintained and to prove itself of use in the big test of national service, must adapt itself to the new conditions and must fit itself for the things that are within its power to perform. And this it often proves is no easy task. War is a minute science and its standards are high. It demands the satisfaction of exacting chemical and physical specifications; the enforcement of rigid inspection methods and a general preciseness of practice which the majority of casting manufacturers seldom are called upon to observe in normal operations. This usually means for the average foundryman new equipment, new methods and more or less reorganization of his shop, both as to the personnel and as to the co-ordination of the processes of production. It frequently requires extensions of capacity. In some cases, entirely new plants have been erected to make a specific war essential, such as grenades, ship castings, tractor

parts and other lines. All of this involves not only initial plant expense and increased overhead, but delays, losses and difficulties of production which are incident to the undertaking of any new line of output.

It requires little imagination to grasp the sweeping changes that must have taken place to put a stove foundry, a cast-iron pipe shop, or an ordinary jobbing plant on a basis where it may successfully turn out in quantity, cast shells made to millimeter dimensions. Such a transformation indicates the radical readjustment which actually has been taking place in many parts of the foundry industry today, and as a result of which the striking power of the nation has been materially increased. It should be a source of gratification to the whole country and a mark of credit to the initiative and spirit of the industry that many casting plants have responded so promptly and well to the nation's call.

The Six Elements of Industry

But as the situation has developed, it is becoming more and more evident that the foundryman is acting with little choice in the matter. His is and promises to become more so, a real and vital problem. It is not too much to say that the existence of many plants for the near future, at least, is at stake. Only by the foundryman engaging in the casting of some product entering into the needs of war or into those channels of consumption which are deemed essential to public interest under wartime conditions may he assure himself of those elements of industry without which he cannot operate. Every announcement and move at Washington by those in control of war industry clearly has revealed this fundamental condition. These elements of industry are described as labor, capital, facilities, material, transportation and fuel. The war industries board under date of Sept. 7 issued what is described as the "master key" governing the requirements of present industry. This is known as Preference List No. 2. It defines essential industry and classifies it according to its relative importance. In effect it distinguishes between what is essential and what is not essential in industry under prevailing conditions. It will serve as a guide to foundrymen in settling for themselves the trouble-

some question as to what does and what does not constitute essential work and it should be consulted carefully.

The key to the foundryman's position at the present time is his supply of pig iron. Only by getting his plant on war and essential work may he be able to count upon a supply of this indispensable material; and then only to the amount of iron required by the percentage of his capacity that is so en-

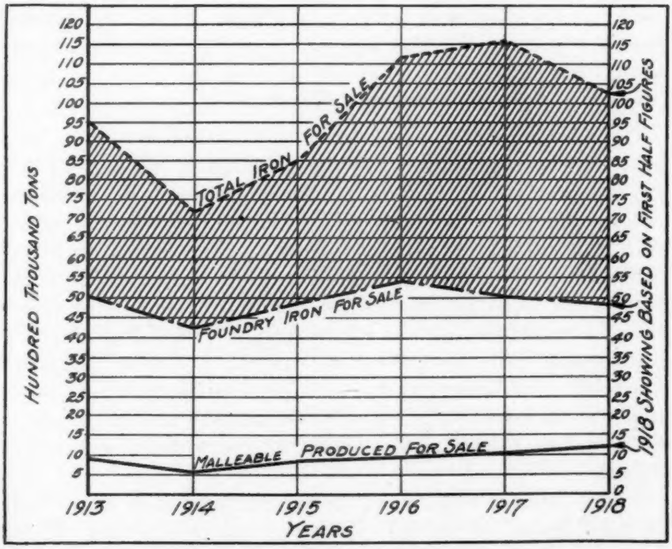


DIAGRAM SHOWING PRODUCTION FOR SIX YEARS

gaged. In other words, such requirements as arise from specific war or essential work are being supplied. Beyond that, no assurance of material is held out by the government authorities. The course of wisdom for the average foundryman is obvious. The steel director, in whose charge is the present distribution of pig iron, has repeatedly sounded the extreme need for the strictest conservation of pig iron and the necessity of every foundryman so altering his accustomed practice as to permit of that economy. The pig iron supply of the country is short, considerably so. There is no possible way by which the tonnage

lacking can be made up. This stringency and the general labor situation, point to materially reduced production by the foundries as the war goes on. The more liberal use of scrap in mixtures is not likely to offer much permanent relief since the supply of cast and other cupola metal is shrinking and replenishment of stocks by the yards and dealers is becoming more uncertain; furthermore the growing shortage of labor makes it more difficult to sort the considerable amount of scrap which comes on the market in a mixed condition. In the steelmaking grades of scrap, the shortage of supply already has become acute.

What an Allocation is

Allocation is a word of which we are hearing a great deal today, but its significance and the workings of the system that it represents are not always clearly understood. An allocation is an order and it is primarily applied to raw material rather than to manufactured articles. Thus we have allocations of pig iron and steel which are regarded as basic materials. It would be well not to go too far into the technical phases of the rather complex machinery of the government for regulating the flow of essential materials except to say that no priority ratings are given to different demands for pig iron because that metal is put at the root or starting point of industry and the supply is to be so distributed or husbanded as the imperative demands dictate.

The primary function of the pig iron section of the division of steel supply of the war industries board is to procure pig iron for governmental orders. A manufacturer having been given a government order for certain material and feeling that the tonnage of pig iron which he has in stock and on order is insufficient to enable him to complete this work, applies to the department which placed the order or to the director of steel supply, for such additional quantity of iron as will enable him to carry out his contract.

Should the application come to the director of steel supply, it is referred to the proper government department which has, or will secure through investigation, the data necessary to enable it to make a request for an allocation of the amount of pig iron needed. To determine the proper tonnage full infor-

mation is secured as to the weight of the castings required to complete the contract; the amount of iron the manufacturer has in stock, in transit or on order; the analysis preferred; the usual source of supply; and the percentage of scrap normally used by the manufacturer.

This information is carefully considered by the government department which then makes a formal request on the director of steel supply for the tonnage of pig iron considered necessary, submitting with the request confirming data. The case is then considered by the pig iron division which has in addition to the information submitted by the government department, data secured from the questionnaires returned by the producers, from personal interviews with various manufacturers, from investigation and from various other sources. All these facts are taken into account in arriving at a final decision. In certain cases it has been found that the manufacturer was not entitled to an allocation as he had sufficient iron on order and merely needed assistance in having it shipped. There have been cases where allocations were refused on the ground that the manufacturer would be able to fill his contract from his own iron if he would conserve it by using a proper proportion of scrap in his mixture. In this connection it may be stated that aside from performing valuable service in conserving pig iron and properly distributing the available supply, the pig iron division is doing considerable educational work. This is accomplished by eliminating many of the old rule-of-thumb methods of the foundries dating back to the days when iron was graded by fracture instead of analysis; and by showing the foundrymen how they can make advantageous changes in their practice. This latter course includes increasing the amount of scrap used, combating the idea that four or five brands of iron are necessary to make up a mixture, discouraging the extravagant use of higher silicon iron, etc. It is pointed out that these methods will help the foundrymen to hold their organizations together and protect their invested capital, should it become necessary to reduce the supply of foundry iron.

The amount of pig iron required by the manufacturer under consideration having been determined, a regular allocation request form is made out by the pig iron division and is sent

to the committee on pig iron, ore and lake transportation of the American Iron and Steel institute which has headquarters at Cleveland. The latter suggests the furnace which is to furnish the tonnage.

Trade Customs Respected

It is the intent and endeavor of the director of steel supply to upset trade customs and usages as little as possible. On receipt of the allocation request, the local committeemen of the district in which the manufacturer for whom the iron is to be secured is located, make every effort to place the order with the furnace which has usually served the particular user unless such an allocation would involve cross haulage or some similar circumstance. But should the furnace in question have so many allocations that it cannot accept further tonnage, the committeemen then endeavor to place the allocation with the furnace most conveniently situated to supply the manufacturer's needs. In such cases, due consideration is paid to the various phases of the railroad situation, the rate of freight, similarity of the iron to that ordinarily used, time required for delivery and other conditions. There have been cases, however, when it was impossible to observe the conditions outlined as when the grade of iron needed could only be supplied from another district. In such cases the question of supply has been considered paramount.

The furnace to receive the order having been determined, the director of steel supply is notified. After he authorizes the allocation, the manufacturer is advised either by the government department for the completion of whose order the iron is needed, or in certain cases where the pig iron section has requested the allocation, by the director of steel supply, that he may send his regular formal order to the designated furnace. The order calls for specified tonnage and grade of iron which is to be shipped at a prescribed rate. Accompanying this notification is an "authority" from the government department or the director of steel supply which serves to give the furnace assurance of the governmental validity of the manufacturer's order.

In cases where iron already ordered by the manufacturer is needed for the completion of government work, the director of

steel supply instead of allocating, upon presentation of proof that the iron is required for governmental purposes writes the furnaces direct "ordering in" the iron. These instructions have all the weight of an allocation. Like an allocation, shipments under such instructions have preference over any other shipments even though every other order on the furnace books as developed by the questionnaires, is shown to be for 100 per cent governmental purposes.

A War of Ingots

Much has been said and written as to this being a war of steel. Rather it might be said it is a war of ingots instead of one of castings. At least it has been such for some months, though the situation now is undergoing considerable change.

Germany, to all reports, has been putting to good use her foundry capacity for the production of primáry war material. This is in the making of cast shells. This country proposes to do likewise. In the tremendous semisteel shell program which the war department now is unfolding, there is an opportunity opened to miscellaneous foundries to materially increase their direct participation in war production and their standing as plants of the preferential class entitling them to pig iron and other essentials. The program as now outlined calls for a total of 33,000,000 of 3, 4.7, 6 and 8-inch shells. It is estimated that these orders ultimately may take up 25 per cent of the capacity of the casting plants of the country. At least 1,000,000 tons of metal are involved which on the basis of the usual semisteel mixture would mean 600,000 to 700,000 tons of pig iron and 300,000 tons of scrap. Malleable as well as gray-iron shops now are preparing to engage in the making of semisteel shells on a big scale.

It would be difficult to estimate the actual percentage of foundry capacity that now is engaged in turning out direct or indirect war work. Six months ago, it was a comparatively meager total. Questionnaires returned by foundry consumers to the furnaces in May made a low showing on direct war work. This ran from about 10 to 25 per cent. The indirect war demands, however, were considerably larger. It is doubtful, however, whether at that time more than 50 per cent of melting capacity was taken up by orders in any way related

to war. Since then the foundries have been more active in putting their facilities at the disposal of the government and in determining what portion of the war program they could fit themselves to do. The result has been a steady increase in war work among the casting plants. This is reflected by the figures of iron allocated by the committee on pig iron, iron ore and lake transportation during the past five or six months. Out of 1,105,000 tons allocated from May 1 to Oct. 1, 313,000 tons have been of foundry grade. This is the largest tonnage for any single grade excepting basic with 434,000, and is in fact in excess of the latter as far as domestic consumption is concerned. This is because the basic so placed included 180,000 tons of basic for the British government. Allocations of malleable iron since May were 112,000 tons and of low phosphorus iron, 125,000 tons. With but minor exceptions all this iron is for delivery this year.

These increased allocations of foundry iron also tell another story. They reveal the growing difficulties of the foundry users in obtaining their supplies from their usual sources. This is due to the shrinking production of foundry iron. More unfilled tonnage of foundry iron is on the books of sellers today than in any other grade. This largely was entered by the usual route of open market purchases before the government took a close grip upon distribution. When it can be delivered, if at all during the period of the war, is a question.

The Shortage of Pig Iron

Production of pig iron in 1918 was begun with an estimated shortage of over 500,000 tons. This was occasioned by the severe weather conditions and the freight tieups which seriously affected the operations of the furnaces in November and December. These conditions continued through January and February and by March 1 the estimated shortage stood at over 1,500,000 tons. It was appreciated by those who analyzed the situation that the foundries, especially those in the gray-iron class, were likely to suffer severely from the shortage. This was because the heaviest and most pressing war demands being for steel, it was realized that the production of steel-making pig iron would be favored and that as far as possible,

the loss of tonnage would be made up by switching more furnace capacity to these grades. This meant that a number of stacks producing foundry iron would be changed over. This is exactly what has happened.

Under a growing shortage of steelmaking iron, especially basic, this transposition from foundry, bessemer or malleable, to basic production by the merchant furnaces has been marked. Probably not less than a dozen furnaces have been changed over since this country went to war. At Cleveland six stacks, of which at least four had been making foundry or malleable for sale, now are all making basic. The production of foundry iron in the Chicago district has been cut down materially by the same cause; a similar condition has been shown in the Mahoning and Shenango valleys, in southern Ohio and in eastern Pennsylvania. In Alabama, three companies are producing portions of an order for 80,000 tons of basic allocated to them for England which is to go to the repayment of iron and steel borrowed from the British government by General Pershing for the American Expeditionary Forces. Recent years have witnessed the increasing union of merchant blast furnaces with steel works which were rounding out their sources of pig iron supply and this has brought about some contraction of the tonnage of iron made for the market, including a liberal amount of foundry iron. The apparently insatiable demands for steel from this country since it engaged in the world war, however, have been responsible for the accelerated increase of basic iron production at the expense of other grades.

In considering the prospects of the foundry industry as to future pig iron supplies, it is well to review iron production in this country since the world war began.

Foundry Iron a Straggler

The output of foundry iron in that period has not kept pace with general production. In 1914, of the total tonnage of 1913. In 1915 this proportion had dropped to 55.9 per cent, in 1916 to 48.6 per cent and in 1917, nine months of which iron made for sale by the blast furnaces of the country, 59.7 per cent was of the foundry grade. This represented an increase from 53.4 per cent of the merchantable iron made in

found the country at war, to 44.4 per cent. In the first half of 1918, however, it rose to 47 per cent.

The relation of foundry iron made for sale to the total of all grades produced for the market since 1913 is as follows:

Year	Total iron for sale tons	Foundry iron* for sale tons	per cent
1913	9,523,885	5,084,952	53.4
1914	7,362,980	4,393,089	59.7
1915	8,583,007	4,801,711	55.9
1916	11,253,317	5,473,196	48.6
1917	11,676,513	5,186,498	44.4
1918 (First six months)	5,226,245	2,458,412	47.0

*These figures also include ferrosilicon and almost all the charcoal iron made in the country.

The record of malleable iron has been more irregular. It shows both decreases and increases during the war period. Its relation to total production made for sale is as follows:

Year	Malleable produced for sale tons	Percentage of total merchant iron
1913	989,241	10.4
1914	671,771	9.3
1915	829,921	9.7
1916	921,486	8.2
1917	1,015,579	8.7
1918 (First six months)	563,279	10.8

During the first half of 1918, foundry iron produced for sale fell off 90,377 tons from the first half of 1917, and 179,279 tons from the last half of 1917. The rate of foundry iron produced for sale to the total amount of iron made for the market during the first half of 1918, however, it will be noted, increased to 47 per cent. This increase was due to the fact that the output of iron made for sale in all grades during the first six months of 1918 declined at a higher rate than in foundry iron.

Against the first half of 1917, the six months loss in merchant iron of all grades was 458,544 tons and against the second half of 1917, 765,479 tons. In looking for an explanation for this, it is found in the tonnage of bessemer iron made for sale. A loss of something like 400,000 tons in the bessemer made for the market during the first half of 1917 and of 500,000 tons during the last half of 1917 is shown by the figures for the

first half of 1918. This precipitate drop in bessemer is the sequel to the abnormal increase in the demand for this grade which was the basis for the rapid expansion of the export trade in pig iron of this country in 1916 and 1917. In 1916 we exported 607,236 tons of all grades and in 1917, 653,931 tons as against 277,648 tons in 1913. Our exports now are running at about 200,000 tons annually.

Basic Holding Its Own

The dominating feature of the production statistics for the first half of 1918 is that basic iron output, notwithstanding the reduced operating capacity at the start of the year, has held its own. The total of this grade produced in the first half of 1918 was 8,617,692 tons against 8,620,604 tons in the first half of 1917 and 9,051,058 tons in the last half of 1917. It is apparent that in overcoming the loss in basic output occasioned by the low rate of operations at the beginning of the year, bessemer and foundry capacity was utilized. The conclusion is plain that basic production has the right of way and will be maintained at the expense of other grades, as necessary.

The significance of the comparisons shown of the production statistics from 1913 to 1918 is this: The demands for foundry iron have not increased in anything like the proportion as steelmaking iron, particularly basic. While the total tonnage of iron of all grades made for the market increased by over 22.6 per cent between 1913 and 1917, the proportion contributed by foundry iron declined approximately 9 per cent. In the same period the total output of all blast furnaces, that is both steel works and merchant stacks, expanded from 30,966,152 tons to 38,620,967 tons or 24.7 per cent. The relation of the foundry iron made to the total production in the same period declined from 16.8 per cent to 13.4 per cent. It is well to point out here that all but a negligible quantity of foundry iron which has been produced in the country in recent years is for sale, or to put it another way, all the gray iron foundries of the country buy their metal in the open market.

The relative decline in foundry iron production since 1914 necessarily does not mean a falling off in the output of gray

iron castings in the war years. The number of gray iron shops in the United States in fact increased from 4267 in 1916 to 4325 in 1918. The missing factor is supplied by the scrap consumed. There is no way of ascertaining how much scrap went into foundry mixtures during these years. Basing an opinion on the usual practice and existing conditions, however, it is safe to say that the proportion of scrap to pig iron was materially increased. This is because a high market for pig iron always operates to swell the amount of comparatively lower-priced scrap the foundryman puts into his castings. In 1914 and 1915 there was a low market on both iron and scrap. In 1916 the market for No. 2 foundry at Chicago and at Birmingham registered an advance of from $9.50 to $12.50 per ton and No. 1 cast at Chicago and in eastern Pennsylvania from $2 to $4.50 per ton. In 1917 occurred the climax of the phenomenal rise in prices. No. 2 foundry at Chicago went to $55 and at Birmingham to $50. No. 1 cast rose to $31 at Chicago and to $38.50 in eastern Pennsylvania. These comparative prices without doubt tell their own story. It will be well to bear in mind in this connection that the supply of scrap today is short as well as of pig iron which means less freedom to regulate mixtures.

All statistical studies of pig iron production and of the irreducible demands both for waging the war and for the maintenance of national life, point in only one direction. They emphasize the uncertainty and the instability of the position of the foundry industry taken as a whole. They proclaim the urgent necessity for the foundry plants of this country to readjust themselves so that they shall effect every possible economy in the use of iron and to concentrate their attention only upon such work as clearly shall be of an indispensable character. If they do not, no one would care to predict the consequences. The suggestion from Washington on this point is direct and unmistakable.

Even were this not the case, the tremendous demands for steel from the government and its allies and from the essential nonwar requirements of the country would be deeply significant. At present these orders, the steel director estimates, aggregate at least 23,000,000 tons, representing a practically eight months'

production and they are still growing. To fill them every steel works in the country must be driven at top speed for an indefinite period. This means the providing of constantly maximum supply of all elements of production, at the base of which is pig iron. Modern war largely is in terms of steel. It conscripts blast furnaces as readily as it does human lives.

In the words of Judge Edwin B. Parker, chairman of the priorities division of the government, steel is the most precious metal in the world today. With equal truth he could have said the same of pig iron, for without it no steel is possible. It becomes, therefore, the highest patriotic duty of every foundryman in this country to make every ton of pig iron count for its full value. Waste today is more than an economic, it is a national loss. Every foundry proprietor, manager or superintendent should keep before him daily the fact that for each ton of pig iron wasted, 3300 hand grenades are lost to the boys in the trenches.

Ferruginous and Other Bonds in Molding Sands

By PROF. P. G. H. BOSWELL, Liverpool, England

In the first place the author desires to thank the American Foundrymen's association for the opportunity afforded to him of attending the 1918 conference in person.

The present paper is brought forward rather with the idea of stimulating discussion than with any other object. At the same time it presents certain accurate data not hitherto available, which may at least be useful for comparison and reference.

Modern foundry practice, so far as the use of molding sands in the casting of steel is concerned, falls into one or other of two classes. In the countries of western Europe, particularly Great Britain, France, Belgium and Germany, the practice has been to use naturally bonded molding sands, that is, sands such as "French Red", consisting of comparatively coarse material bound together with clay substance and ferric hydroxide. To a much smaller extent (but, as is well known, widely in the United States) it is the practice to use highly siliceous sands bonded artificially with such substances as sugar, dextrim, molasses, oil, "sulphite-lees" (a by-product from the manufacture of paper) and others. Sometimes fireclay, with or without one of the artificial bodies just mentioned, is added for the same purpose. The strength of naturally bonded sands is occasionally increased by the use of similar artificial substances. Particularly is this the case when the binding material, as in the Scottish "rotten rocks" or "rotten stones" is insufficient by itself to yield the structural strength required. The bond of the rotten rocks used so largely in the Clyde valley and the district around Glasgow, consists of micaceous and kaolin-like material, which, however, is not so plastic as is desirable.

The naturally bonded molding sands used in Britain may be divided into two chief classes: (a) Those used in casting iron, and also brass, bronze and other nonferrous alloys; (b) those used for steel.

Of the former, some of the best known are the Red Bunter sands from Mansfield and Birmingham, the Erith loam, Thames sand, etc. Among the latter are the famous "Belgian Red", "Belgian Yellow", "French Red", "French Yellow", "Cornish Red", South Cave (Yorks), Huttons Ambo (Yorks), Barrow-in-Furness (Lancs), sand from South Africa and other localities.

The bond of molding sands may be regarded from two distinct points of view, (a) as a mixture of certain chemical compounds, the composition of which has been obtained in the course of chemical analysis, and (b) from the point of view of texture—the finest-grained material present in the sand, the relative quantity being estimated by mechanical analysis (elutriation). The clay grade was estimated by H. Ries by settlement (see Transactions, American Foundrymen's Association, 1906) but this method is not sufficiently accurate.

Considering first the mechanical analyses, the following table indicates the grade composition of some of the best steel molding sands:

Percentage Weights

	CS Coarse sand grade 0.5 to 1 mm	MS Medium sand grade 0.25 to 0.5	FS Fine sand grade 0.1 to 0.25	cs Coarse silt grade 0.05 to 0.1	fs Fine silt grade 0.01 to 0.05	c Clay grade under 0.01 mm	S Total sand grade, over 0.1 mm per cent
Belgian Yellow......	7.5	64.9	12.0	3.3		12.3	84.4
French Red	0.6	18.0	62.7	3.1		15.6	81.3
Cornish Red.........	0.6	37.3	42.7	5.7		13.7	80.6
Barrow - in-Furness.	5.5	39.6	32.6	0.2	6.2	15.9	77.7
Huttons Ambo....... Yorks	0.4	16.1	72.0	0.2	0.3	11.0	88.5
Auchenheath N. B..	27.5	41.1	26.2	0.2	1.0	4.0	94.8
South Africa	0.5	3.4	70.5	1.0	6.3	18.3	74.4
A "core-sand" mixture	9.0	10.4	57.8	0.3	4.8	17.7	77.2
A good "greensand" mixture	4.2	15.3	61.9	0.2	2.5	15.9	81.4

Several interesting points arise from this table. The sand grade in each case is seen to be relatively high in amount, the

clay grade, which acts as bond is also present in quantity, but the intermediate silt grades are relatively small in proportion. From the point of view of the use of the sand in the foundry, this means that there must be an abundance of coarse open sand to keep the mold well vented and to allow free passage of gases, etc., and that the clay grade or bond must be sufficient; but intermediate fine material such as silt, which would pack the pores of the mold and prevent good ventilation should be absent or present only in small quantity.

From the chemical analyses of the sands, particularly by interpreting the analyses "rationally" we may also obtain interesting information regarding the bond. From the "bulk" chemical analyses given in the following tables perhaps the one outstanding feature is the relatively high percentage of ferric oxide (estimated as Fe_2O_3). If instead of making bulk analyses, we submit the material of various grades, as obtained by elutriation, to chemical analysis, several interesting points are brought out. In the following tables chemical analyses of the material from various grades separated from well known molding sands are given:

Bulk Chemical Analyses of Molding Sands

	Per cent				
	(1)	(2)	(3)	(4)	(5)
Silica ....(SiO_2)..	86.47	89.88	77.29	77.61	86.11
Alumina ....(Al_2O_3..	4.96	3.29	2.46	8.60	5.29
Ferric Oxide ....(Fe_2O_3)..	2.58	2.23	14.16	4.81	2.45
Ferrous oxide ....(FeO)..	0.29	0.25	0.13	1.40	0.29
Magnesia ....(MgO)..	0.37	0.24	0 31	0.22	0.47
Lime ....(CaO)..	0.26	0.24	0.81	0.16	0.40
Soda ....(Na_2O)..	0.12	trace	0.23	0.04	none
Potash ....(K_2O)..	0.47	0.64	0.52	0.46	0.95
Water above 110° C.(H_2O+)..	2.44	1.76	2.58	4.05	2.26
Water below 110° C.(H_2O-)..	1.54	0.74	0.95	0.92	1.31
Carbon dioxide ....(CO_2)..	none	none	0.31	trace	none
Titanium dioxide......(TiO_2)..	0.40	0.36	0.15	1.41	0.34
Zirconia ....(ZrO_2)..	none	trace	n. d.	0.06	trace
Phosphorus pentoxide.(P_2O_5)..	0.09	0.11	0.36	0.13	0.08
Sulphur trioxide.......(SO_3)..	none	none	none	0.04	0.20
Chlorine ....(Cl)..	trace	trace	trace	trace	none
Manganic oxide......(MnO)..	trace	trace	0.06	0.04	trace
Barium oxide.........(BaO)..	trace	none	none	none	none
Total	99.99	99.74	100.32	99.95	100.15

(1) Belgian yellow, (2) French red, (3) South Cave red (Yorks), (4) South African sand, (5) Cornish red.

Chemical Analyses of Various Grades from Molding Sands

Belgian Yellow

	Per Cent				
	CS. & MS.	FS.	cs.	fs.	c.
SiO_2	98.63	96.73	75.57	56.69	45.60
Al_2O_3	0.19	1.09	9.82	17.96	22.19
Fe_2O_3	0.22	0.69	5.37	9.85	10.74
FeO			0.40	0.43	1.13
MgO	0.12	0.15	0.66	0.99	1.26
CaO	0.36	0.17	0.72	1.09	1.84
Na_2O	none	0.11	0.20	0.32	0.38
K_2O	0.08	0.29	0.99	1.35	1.56
TiO_2	none	0.11	0.95	1.42	1.24
Loss on ignition	0.25	0.88	5.80	10.37	14.24
Totals	99.85	100.22	100.48	100.47	100.18

Cornish Red

	Per Cent			
	FS 0.1 to 0.25 mm.	cs. 0.05 to 0.1	fs. 0.01 to 0.05	c. under 0.01
SiO_2	96.73*	92.07	55.34	46.67
Al_2O_3	1.04	3.02	18.87	20.78
Fe_2O_3	0.50	1.25	9.85	12.89
FeO		0.20	0.47	0.41
MgO	0.13	0.17	1.27	1.52
CaO	0.26	0.38	0.95	2.27
Na_2O	0.08	0.09	0.18	0.40
K_2O	0.38	0.89	2.02	2.29
TiO_2	0.14	0.42	0.85	0.85
Loss on ignition	0.63	1.21	10.14	12.29
Totals	99.89	99.70	99.94	100.37

*Duplicate determination of silica 96.65 per cent.

South African Sand

	Per Cent				
	MS. 0.25 to 0.5 mm.	FS. 0.01 to 0.25	cs. 0.5 to 0.1	fs. 0.1 to 0.05	c. under 0.01 mm.
SiO_2	96.53	95.07	47.60	44.02	42.75
Al_2O_3	1.06	1.04	23.96	22.58	25.88
Fe_2O_3	1.00	1.83	12.91	13.47	12.86
FeO			0.50	0.52	0.67
MgO	none	0.13	0.30	0.46	0.52
CaO	0.17	0.17	0.67	1.02	1.35
Na_2O	0.09	0.03	0.15	0.29	0.10
K_2O	0.28	0.20	0.72	0.74	0.73
TiO_2	0.34	1.34	1.12	1.00	1.05
Loss on ignition	0.56	0.44	12.32	13.22	14.02
Totals	100.03	100.25	100.25	100.32	99.93

With these may be compared similar analyses of the graded portions of a well known Banter iron molding sand from Wolverhampton:

Chemical Analyses of Grades

Bunter Sand, Compton, Near Wolverhampton

	Per Cent				
	MS. 0.25 to 0.5 mm.	FS. 0.1 to 0.25	cs. 0.5 to 0.1	fs. 0.1 to 0.05	c. under 0.1
SiO_2	94.37	89.10	85.31	69.05	58.17
Al_2O_3	2.82	5.32	6.95	14.15	19.58
Fe_2O_3	0.46	0.88	1.23	2.70	5.47
FeO			0.22	0.53	0.55
MgO	0.17	0.28	0.37	1.05	1.78
CaO	0.16	0.24	0.41	1.27	1.34
Na_2O	0.12	0.15	0.49	0.56	0.38
K_2O	1.57	3.13	3.31	5.45	5.37
TiO_2	0.06	0.21	0.43	0.97	0.73
Loss on ignition	0.48	0.71	1.43	4.28	6.34
Totals	100.21	100.02	100.15	100.01	99.71

The first fact of importance which these tables indicate is that the sand grade in each case consists of a "high-silica" sand. The following are the respective figures:

Medium and Coarse Sand Grade

(MS. & CS.; under 0.25 mm. diameter)

	Per Cent	
	Belgián	South Africa
SiO_2	98.63	96.53
Al_2O_3	0.19	1.06
Fe_2O_3	0.22	1.00
MgO	0.12	none
CaO	0.36	0.17
Na_2O	none	0.09
K_2O	0.08	0.28
TiO_2	none	0.34
Loss on ignition	0.25	0.56
Totals	99.85	100.03

Fine Sand Grade

(FS.; 0.25 to 0.1 mm. diameter)

	Per Cent		
	Belgian	Cornish Red	So. Africa
SiO_2	96.73	96.73	95.07
Al_2O_3	1.09	1.04	1.04
Fe_2O_3	0.69	0.50	1.83
MgO	0.15	0.13	0.13
CaO	0.17	0.26	0.17
Na_2O	0.11	0.08	0.03
K_2O	0.29	0.38	0.20
TiO_2	0.11	0.14	1.34
Loss on ignition	0.88	0.63	0.44
Totals	100.22	99.89	100.25

The percentages of alkalies (potash and soda) and alkaline earths (lime and magnesia) are seen to be very low, thus the sand is highly refractory. The alumina percentage is not high, and the small quantity of ferric oxide present is mostly distributed as thin pellicles round the quartz grains which constitute the bulk of the sand.

The silt grades being unessential and present in small amount, it will be better to consider next the clay grade. A comparison of the chemical analyses is as follows:

	Per Cent					
	Belgian		Cornish Red		South Africa	
SiO_2	45.60		46.67		42.75	
Al_2O_3	22.19		20.78		25.88	
Fe_2O_3	10.74	11.87	12.89	13.30	12.86	13.53
FeO	1.13		0.41		0.67	
MgO	1.26		1.52		0.52	
CaO	1.84		2.27		1.35	
Na_2O	0.38		0.40		0.10	
K_2O	1.56		2.29		0.73	
TiO_2	1.24		0.85		1.05	
Loss on igni.	14.24		12.29		14.02	
Totals	100.18		100.37		99.93	

With these analyses may be compared those of two well known British fireclays of high quality:

	Per Cent	
	Church Gresley	Glenboig (A.1)
SiO_2	46.45	46.53
Al_2O_3	35.82	36.57
Fe_2O_3	1.31	1.80
MgO	0.09	0.21

CaO	0.47	0.22
Na_2O	0.76	0.37
K_2O	1.08	
TiO_2	2.65	1.47
Loss on ignition	12.14	13.16
Total	100.71	100.33
	Anal. J. W. Mellor.	Anal. A. Knox.

Obviously, the clay grade of the molding sands separated constitutes a high grade, refractory fireclay. There is, however, one marked difference. In each case the percentage of ferric oxide is much higher, and—a related fact—the loss on ignition is sometimes greater.

The reason for the tendency in the steel industry toward the use of high-silica sands bonded with a small quantity of fireclay, and some artificial substance is thus explained and justified. The method, however, does not result in the addition of ferric oxide to the sand, although an old formula for molding sands was as follows:*

	Parts
Fine quartzose sand	93
Red English ochre	2
Aluminous earth, as little calcareous as possible	5
	100

*Kaupmann: Ann. des Mines, S. 4 (1845), Vol. VII, P. 689

The difficulty obviously lies in the effective mixing of fireclay and sand, with or without ochre. Natural agencies succeed in coating each quartz-grain more or less completely with clayey and ferruginous material. Fireclay containing fine siliceous substance should clearly not be used, since it introduces silt grade material which fills the pores of the mold and tends to cause blowholes, scabs, etc.

It is noteworthy that castings made from naturally bonded ferruginous molding sands usually possess a smooth steel-blue surface. The color appears to be due to the formation of magnetite from the ferric hydroxide in the sand. In the case of castings made from the Scottish "rotten rocks" containing little or no iron, the skin is grayer in tint and is frequently less smooth. The use of "French Red" sand for facing molds in the United States should have the effect of yielding a blue smooth skin.

W. R. Bean has recently, in the transactions of this association, declared that iron oxide in molding sands is detrimental. It would appear to be desirable to have further information regarding both the chemical and physical state of the iron oxide. The washing away of the sand ("scabbing") from the surface of the mold rather points to packing of the pores by silt-grade material.

The chief natural bonds in molding sands are thus ferric hydroxide and clay substance (silicates of alumina, fine micas, etc.) These, like many of the artificial bonds in common use are colloidal bodies, that is, substances exhibiting surface phenomena to a very marked extent. Most substances when sufficiently finely divided, can be obtained in the colloid condition. Many colloids are so constituted as to be able to absorb large quantities of water. The plasticity of clays, too, may be increased by an admixture of other colloids such as colloidal silica, alumina, etc. The absorptive power of clay, in the matter of both gases and solutions increases, according to Senfft, with the liminitic content. J. Van Bemelen found, as long ago as 1878, that the amount of "hydrate water" of ferric oxide was variable and accidental. When just dry at 15 degrees Cent., the compound is able to take up over six molecules of water per molecule of ferric oxide.

These facts throw interesting lights upon the bonds of molding sands. One of the most marked characteristics of the best sands is their extraordinary power of taking up considerable quantities of water without really becoming wet. The following figures, for example, are those of hygroscopic water (liberated at 110 degrees Cent.) contained in a few molding sands (some of them moist, but none wet) as collected in the field:

	Per Cent	
Cornish red	11.6	
Erith, strong	10.2	
Belgian yellow	6.6	(Partly dried)
Wolverhampton	13.5	
Kidderminster	8.0	

Another important desideratum of good molding sands, possibly connected with the colloidal character of the bond, is that they should not "go dead", that is, dehydrate too readily

after metal has been cast in them. Iron oxide readily hydrates again, unlike clay, which may be "porcellanized" by heat.

The distribution of the bond in naturally bonded sands is ideal. Each grain of quartz is coated with a thin pellicle of ferric hydroxide or ferruginous clay. Water skins cannot hold on to clean quartz, but each coated grain assumes the skin of water which with its neighbors constitutes the enormously strong, "guey" bond of the sand.

The effect of "milling" or "mulling" of molding sands is well known. Not only are lumps broken down, but the bond is considerably improved. This is doubtless due to the more even distribution of the binding material around the quartz grains—a result of the rolling.

It is noteworthy that in west European sands, the higher the percentage of ferric hydroxide, the greater is the transverse strength of the sand. In the case of the sand from South Africa, analyses of which were quoted, containing 4.81 per cent of ferric oxide, the molds produced were of extraordinary strength and toughness.

A final note may be added upon the famous group of British Bunter molding sands, not sufficiently refractory to be used for steel casting, but widely employed in the casting of iron, brass, bronze, etc. The sands, of which well known examples come from Kidderminster, Birmingham and Mansfield, are of a bright red color, having probably been river-deposited under desert conditions. The sands are fairly well graded and contain little clayey material. Each grain of quartz is, however, evenly coated with iron oxide, in the form of either hematite or limonite. Chemical analysis shows that in each case the actual quantity of ferruginous compounds in the sands is considerably less than would be expected (see table below) from the deep color of the material. The distribution is, however, almost perfect, and the strength of the bond, when the sands are moist, is remarkable.

Mechanical Analyses—Bunter Sands

	Per Cent							
	CS.	MS.	FS.	cs.		fs.	c.	S
Birmingham (open).	0.2	67.1	28.0		1.6		3.1	95.3
Heck (Yorkshire)...	0.2	77.0	14.7		8.8		0.3	91.9
Mansfield	4.4	78.8	11.4	0.3		0.9	4.2	94.6
Wolverhampton	trace	27.8	64.6	1.7		1.0	4.9	92.4

Chemical Analyses—Bunter Sands

	SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O
Aughton Park, Ormskirk......	92.30	3.94	0.34	0.15	0.16	0.12	0.03
Belfast, Lagan Vale..........	74.80	7.70	1.13	0.56	1.33	4.55	1.34
Birm'g'h'm, Hockley Cem., close.	84.86	6.69	1.08	0.35	0.43	0.29	0.40
Compton, nr. Wolverh'pt'n (bulk)	86.37	6.40	0.96	0.25	0.42	0.26	0.36
Heck, near Selby..............	87.14	5.89	1.00	0.29	0.41	0.25	0.14
Kidderminster, Station Pit.....	85.66	6.59	0.86	0.36	0.55	0.26	0.16
Mansfield, pig-bed sand........	88.60	5.40	1.08	0.22	0.28	0.18	0.06
Mansfield, lower medium.......	82.51	4.96	0.97	0.30	1.56	2.39	0.10
Staurbridge.....................	95.64	6.48	0.94	0.46	0.43	0.33	0.32

K_2O	H_2O+	H_2O-	CO_2	TiO_2	ZrO_2	P_2O_5	SO_3	Cl.	MnO	BaO	Total etc.
2.14	0.56	0.34	n. d.	0.19	none	trace	n. d.	trace	trace	0.02	100.29
2.65	1.18	0.50	3.52	0.30	n. d.	0.04	0.02	trace	0.04	0.04	99.70
3.41	1.21	0.55	none	0.40	trace	0.09	none	trace	0.01	0.04	99.81
3.25	1.00	0.57	none	0.35	trace	0.06	none	trace	0.01	0.04	100.30
2.95	1.00	0.55	none	0.18	0.02	0.08	0.03	trace	0.02	0.03	99.98
3.41	1.22	0.74	none	0.40	trace	0.10	none	trace	0.01	0.03	100.35
2.20	1.29	0.47	2.92	0.17	n. d.	0.07	none	trace	0.02	trace	99.93
3.20	1.06	0.81	none	0.28	n. d.	0.08	none	trace	0.01	0.02	100.11

Report of Committee on Steel Foundry Standards

Your committee this year has been asked to investigate and report on the technical considerations in the design of drying ovens and core ovens. No originality is claimed for these results and observations, they being based on well established laws of physics together with compilations and researches of other investigations.

Unfortunately in the past, foundrymen in the design of mold drying and core ovens have considered the problem as one of heating with the result that the molds and cores have been placed in direct contact with the flame and products of combustion, to the detriment of the product to be heated and the equipment and with an excess consumption of fuel. Rather than it being a heating problem, it is purely a problem of evaporation. The dependent basic laws are applicable and this evaporation of inherent moisture may be accomplished by the utilization of either artificially heated air or superheated steam in calculated quantities, properly circulated. The use of artificially heated air or superheated steam is to be preferred as an intermediary heating vehicle or medium rather than direct heating, because it is more positive, eliminating the vagaries of firing and may be controlled to meet the required minimum and maximum temperatures of the materials to be dried by gradual evaporation and without sacrificing the physical properties of the material.

In the event that artificially heated air is the drying medium this air must first heat the material, secondly communicate to the material the heat necessary to evaporate the contained moisture, and thirdly to absorb and retain the evaporated moisture. The heated air in the drying chamber loses therein the quantity of heat required for heating the material and evaporating the moisture. The temperature of the air after

having completed this function, must, however, be of a temperature sufficient to retain the absorbed moisture. This temperature necessarily must be higher than the temperature of the external inlet air as it must be able to retain its own initial saturation plus the absorbed evaporated moisture. The temperature at exit should therefore be the highest possible consistent with the nature of the materials.

Atmospheric air always carries with it more or less moisture, the degree of saturation varying with atmospheric conditions and which may approach but rarely reaches complete saturation. The carrying capacity of air for moisture or saturation increases with rising temperatures. In order that the smallest quantity of air may absorb the greatest possible amount of moisture, it should be heated to the highest possible temperature consistent with the material to be evaporated, capable of heating the material, evaporating the moisture and having a discharge temperature high enough to retain the initial material saturation in addition to the absorbed evaporated moisture. The temperature of the heated air is dependent upon the nature of the material and the desired degree of drying. As the expenditure of heat in drying is equal to the heat expended in heating the air, that quantity of air should be as small as possible, and the temperature to which it is heated as high as possible.

Three Primary Factors

In order to determine the required quantity of heat necessary to heat the air, and the required heating surface and the volume of entry air, heated air and discharge air, it is necessary that the following factors be known:

1.—Weight of material to be dried.

2.—Quantity of moisture to be evaporated.

3.—Highest temperature to which material can be subjected.

All of these factors and variables too are dependent upon the drying being conducted at pressures higher or lower than that of the atmosphere.

That air changes its volume under influence of temperature and pressure is well understood, according to the laws of Boyle and Charles. The unit of volume of air must, therefore, always be referred to in terms of its temperature and pressure. The quantity of heat which a definite volume of air at a definite temperature and pressure can give out can be calculated as also the quantity of moisture which it can take up. After this amount of heat has been given out and the moisture has been absorbed, the temperature has been lowered and the volume under this new condition must be again determined. In the calculations, the quantity of air will be referred to in terms of weight which quantity may then be converted into volume.

Where air is completely saturated it is referred to as 100 per cent saturation which means the maximum amount of moisture that a definite volume of air can contain at a definite temperature. This amount of contained water vapor at this definite temperature exerts a definite pressure or vapor tension. In calculating the amount of heated air necessary for drying, a relatively high initial degree of saturation should be assumed; approximately 50 per cent to 60 per cent. The discharge air almost never leaves the drying room completely saturated. Although this desired constituency is never attained for calculation it may be so assumed. The cycle of air changes from external air to discharge air may be observed from Fig. 1.

The external air L which contains d_a pounds of water vapor in one pound of air enters the heating chamber at temperature t_a and leaves a temperature t_h. In passing through the drying room the air takes up water and is thereby cooled to temperature t_n. The warm moisture laden air $ld_n = w - ld_a$ is now delivered to atmosphere or recalculated by condensing the contained moisture.

As previously noted the quantity of heat which the air l and its inherent moisture a can give out in the process of drying in cooling from temperature t_h to temperature t_n must be sufficient to heat the material from temperature t_a to t_l and also to evaporate the contained water.

The air at exit must be in such condition at exact temperature t_n as to retain in the form of vapor the absorbed evaporated moisture w plus the water vapor *lda* which it originally contained. The volume of vapor in the latter which one kilogram of water may evolve, according to the law of Mariotte and Gay Lussac is,

$$V = 4.543 \frac{273 - t}{P}$$

where t is the temperature and p is the pressure in atmosphere.

The weight of 1 cubic meter of saturated water vapor is, therefore,

$$ka = \frac{1}{V} = \frac{p}{4.543\ (273 + t)}$$

This weight may, however, be now easily obtained by assuming that the weight of a unit volume of water vapor is 0.623, the weight of the unit volume of dry air at a given temperature and pressure. The weight of one cubic foot of dry air at a given temperature and pressure may be determined according to the formula,

$$w = \frac{1.3253 \times B}{459 + t}$$

wherein B equals absolute pressure in inches of mercury and t the temperature in degrees Fahrenheit. A table of weights is presented herewith.

WEIGHT PER CUBIC FOOT OF DRY AIR.

Weight of 1 cubic foot of dry air at different temperatures and barometric pressures, as calculated by the formula.

$$W = \frac{1.3253 \times B}{459 + t}$$

Weight of 1 cubic foot of Dry Air (Pounds Avoirdupois)

Temp. degrees F. t	Barometer (In.) B—27	Barometer (In.) B—28	Barometer (In.) B—29	Barometer (In.) B—30
0	0.07796	0.08085	0.08373	0.08662
5	0.07718	0.08002	0.08285	0.08569
10	0.07631	0.07914	0.08196	0.08478
15	0.07550	0.07830	0.08109	0.08388
20	0.07470	0.07747	0.08023	0.08300

Temp. degrees F. t	Barometer (In.) B—27	Barometer (In.) B—28	Barometer (In.) B—29	Barometer (In.) B—30
25	0.07393	0.07667	0.07941	0.08215
30	0.07318	0.07589	0.07860	0.08131
32	0.07288	0.07558	0.07828	0.08098
35	0.07244	0.07512	0.07780	0.08048
40	0.07171	0.07435	0.07701	0.07967
45	0.07099	0.07362	0.07625	0.07888
50	0.07031	0.07291	0.07551	0.07811
55	0.06961	0.07219	0.07477	0.07735
60	0.06895	0.07150	0.07405	0.07660
65	0.06828	0.07081	0.07324	0.07587
70	0.06766	0.07016	0.07266	0.07516
75	0.06701	0.06949	0.07197	0.07445
80	0.06648	0.06884	0.07130	0.07376
85	0.06576	0.06820	0.07064	0.07308
90	0.06519	0.06760	0.07001	0.07242
95	0.06490	0.06699	0.06938	0.07177
100	0.06401	0.06638	0.06875	0.07112
110	0.06288	0.06521	0.06754	0.06987
120	0.06180	0.06409	0.06638	0.06867
130	0.06075	0.06300	0.06525	0.06750
140	0.05974	0.06195	0.06416	0.06637
150	0.05874	0.06092	0.06310	0.06528
160	0.05781	0.05995	0.06209	0.06423
170	0.05688	0.05899	0.06110	0.06321
180	0.05601	0.05808	0.06015	0.06222
190	0.05514	0.05718	0.05922	0.06126
200	0.05430	0.05631	0.05832	0.06033
220	0.05271	0.05466	0.05661	0.05856
240	0.05119	0.05309	0.05498	0.05688
260	0.04978	0.05162	0.05346	0.05530
280	0.04840	0.05020	0.05206	0.05380
300	0.04714	0.04888	0.05063	0.05238
350	0.04423	0.04587	0.04751	0.04915
400	0.04166	0.04321	0.04475	0.04629
450	0.03937	0.04082	0.04228	0.04374
500	0.03731	0.03869	0.04008	0.04146
550	0.03546	0.03678	0.03809	0.03940
600	0.03379	0.03504	0.03629	0.03754
650	0.03227	0.03346	0.03466	0.03585
700	0.03087	0.03202	0.03316	0.03431
750	0.02960	0.03069	0.03179	0.03289
800	0.02842	0.02947	0.03053	0.03158
850	0.02734	0.02835	0.02936	0.03037

Temp. degrees F. t	Barometer (In.) B—27	Barometer (In.) B—28	Barometer (In.) B—29	Barometer (In.) B—30
900	0.02633	0.02731	0.02828	0.02926
950	0.02540	0.02634	0.02728	0.02822
1000	0.02453	0.02543	0.02634	0.02725
1100	0.02295	0.02380	0.02465	0.02550
1200	0.02157	0.02237	0.02317	0.02397
1300	0.02034	0.02110	0.02185	0.02260
1400	0.01925	0.01996	0.02067	0.02139
1500	0.01827	0.01894	0.01962	0.02030
1600	0.01738	0.01802	0.01867	0.01931
1700	0.01657	0.01719	0.01780	0.01842
1800	0.01584	0.01643	0.01701	0.01760
1900	0.01517	0.01573	0.01629	0.01685
2000	0.01455	0.01509	0.01563	0.01617

Having assumed a relatively high degree of initial saturation in the external air and knowing the amount of moisture to be removed, and the degree of saturation of one cubic foot of dry air at the permissible temperature, the total volume of air required may easily be calculated.

The above factors may also be calculated according to the following formulas:

$$\text{Weight 1 cubic foot saturated steam} = \frac{1.325271\ HK}{459.2 + t}$$

H = vapor tension in inches of mercury = 2.036 × (gage pressure and atmospheric pressure in pounds per square inch.)

K = ratio of weight of a volume of saturated steam to an equal volume of dry air at the same temperature and pressure.

$$= .6113 + \frac{.092\,t}{850t}$$

$$\text{Weight of one cubic foot dry air} = \frac{1.325271\,M}{459.2 + t} = \frac{2.698192\,P}{459.2 + t}.$$

M = absolute pressure in inches of mercury.

P = absolute pressure in pounds per square inch.

The maximum weight in pounds of water vapor which one pound of pure dry air can contain when the temperature of the mixture is t and the absolute pressure in pounds per square inch is P, is

$$W = \frac{K\ H}{2.036\ P—H}$$

A table of values of H and K is presented herewith.

TABLES OF H AND K

Values of H and K corresponding to temperatures t from—30 degrees to 434 degrees Fahr.

t	K	H	t	K	H	t	K	H	t	K	H	t	K	H
—30	.6082	.0099	64	.6188	.5962	158	.6323	9.177	252	.6501	62.97	344	.6739	254.2
—28	.6084	.0111	66	.6190	.6393	160	.6326	9.628	254	.6505	65.21	346	.6745	261.0
—26	.6086	.0123	68	.6193	.6848	162	.6330	10.10	256	.6510	67.49	348	.6751	268.0
—24	.6088	.0137	70	.6196	.7332	164	.6333	10.59	258	.6514	69.85	350	.6757	275.0
—22	.6090	.0152	72	.6198	.7846	166	.6336	11.10	260	.6518	72.26	352	.6763	282.2
—20	.6092	.0168	74	.6201	.8391	168	.6340	11.63	262	.6523	74.75	354	.6770	289.6
—18	.6094	.0186	76	.6203	.8969	170	.6343	12.18	264	.6528	77.30	356	.6776	297.1
—16	.6096	.0206	78	.6206	.9585	172	.6346	12.75	266	.6532	79.93	358	.6783	304.8
—14	.6098	.0227	80	.6209	1.024	174	.6350	13.34	268	.6537	82.62	360	.6789	312.6
—12	.6100	.0250	82	.6211	1.092	176	.6353	13.96	270	.6541	85.39	362	.6795	320.6
—10	.6102	.0275	84	.6214	1.165	178	.6357	14.60	272	.6546	88.26	364	.6803	328.7
— 8	.6104	.0303	86	.6217	1.242	180	.6360	15.27	274	.6551	91.18	366	.6809	337.0
— 6	.6107	.0332	88	.6219	1.324	182	.6364	15.97	276	.6555	94.18	368	.6816	345.4
— 4	.6109	.0365	90	.6222	1.410	184	.6367	16.68	278	.6560	97.26	370	.6822	354.0
— 2	.6111	.0400	92	.6225	1.501	186	.6371	17.43	280	.6565	100.4	372	.6829	362.8
0	.6113	.0439	94	.6227	1.597	188	.6374	18.20	282	.6570	103.7	374	.6836	371.8
2	.6115	.0481	96	.6230	1.698	190	.6377	19.00	284	.6575	107.0	376	.6843	380.9
4	.6117	.0526	98	.6233	1.805	192	.6381	19.83	286	.6580	110.4	378	.6850	390.2
6	.6120	.0576	100	.6236	1.918	194	.6385	20.69	288	.6584	113.9	380	.6857	399.6
8	.6122	.0630	102	.6238	2.036	196	.6389	21.58	290	.6590	117.5	382	.6865	409.3
10	.6124	.0690	104	.6241	2.161	198	.6393	22.50	292	.6594	121.2	384	.6871	419.1
12	.6126	.0754	106	.6244	2.294	200	.6396	23.46	294	.6600	125.0	386	.6879	429.1
14	.6128	.0824	108	.6247	2.432	202	.6400	24.44	296	.6604	128.8	388	.6886	439.3
16	.6131	.0900	110	.6250	2.578	204	.6404	25.47	298	.6610	132.8	390	.6893	449.6
18	.6133	.0983	112	.6253	2.731	206	.6407	26.53	300	.6615	136.8	392	.6901	460.2
20	.6135	.1074	114	.6256	2.892	208	.6411	27.62	302	.6620	141.0	394	.6908	470.9
22	.6137	.1172	116	.6258	3.061	210	.6415	28.75	304	.6625	145.3	396	.6915	481.9
24	.6140	.1279	118	.6261	3.239	212	.6419	29.92	306	.6631	149.6	398	.6923	493.0
26	.6142	.1396	120	.6264	3.425	214	.6323	31.14	308	.6636	154.1	400	.6931	504.4
28	.6144	.1523	122	.6267	3.621	216	.6426	32.38	310	.6641	158.7	402	.6939	515.9
30	.6147	.1661	124	.6270	3.826	218	.6430	33.67	312	.6647	163.3	404	.6947	527.6
32	.6149	.1811	126	.6273	4.042	220	.6434	35.01	314	.6652	168.1	406	.6955	539.5
34	.6151	.1960	128	.6276	4.267	222	.6438	36.38	316	.6658	173.0	408	.6962	551.6
36	.6154	.2120	130	.6279	4.503	224	.6442	37.80	318	.6663	178.0	410	.6970	564.0
38	.6156	.2292	132	.6282	4.750	226	.6446	39.27	320	.6669	183.1	412	.6979	576.5
40	.6158	.2476	134	.6285	5.008	228	.6451	40.78	322	.6674	188.3	414	.6987	589.3
42	.6161	.2673	136	.6288	5.280	230	.6455	42.34	324	.6680	193.7	416	.6995	602.2
44	.6163	.2883	138	.6291	5.563	232	.6458	43.95	326	.6686	199.2	418	.7003	615.4
46	.6166	.3109	140	.6294	5.859	234	.6463	45.61	328	.6691	204.8	420	.7012	628.8
48	.6168	.3350	142	.6298	6.167	236	.6467	47.32	330	.6697	210.5	422	.7021	642.5
50	.6170	.3608	144	.6301	6.490	238	.6471	49.08	332	.6703	216.4	424	.7029	656.3
52	.6173	.3883	146	.6304	6.827	240	.6475	50.89	334	.6709	222.4	426	.7037	670.4
54	.6175	.4176	148	.6307	7.178	242	.6479	52.77	336	.6715	228.5	428	.7046	684.7
56	.6178	.4490	150	.6310	7.545	244	.6484	54.69	338	.6721	234.7	430	.7055	699.2
58	.6180	.4824	152	.6313	7.929	246	.6488	56.67	340	.6727	241.1	432	.7064	713.9
60	.6183	.5180	154	.6317	8.328	248	.6492	58.71	342	.6733	247.6	434	.7073	728.9
62	.6185	.5559	156	.6320	8.744	250	.6496	60.81	...	.....	.....	...	.....	.....

The following table calculated from the foregoing gives the weights in pounds of pure dry air, water vapor and saturated mixtures of air and water vapor at various temperatures and at atmospheric pressure 29.921 inches of mercury or 14.963 pounds per square inch. Also elastic force or pressure of air and vapor present in saturated mixture is presented. The table follows:

SATURATED MIXTURES OF AIR AND WATER VAPOR

Temperatures in Fahrenheit Degree	Weight of 1 Cubic Ft. of Pure Dry Air Lb.	Elastic Force of the Vapor In. of Mercury	Elastic Force of the Air alone when Saturated, Ins. of Mercury	Weight of the Vapor in 1 Cu. Ft. of the Mixture, or Wt. of 1 Cu. Ft. of Saturated Steam.	Weight of the Air in 1 Cu. Ft. of the Mixture.	Total Weight of 1 Cu. Ft. of the Mixture.	Weight of Water Vapor Mixed with 1 lb. of air
0	0.086354	0.0439	29.877	0.000077	0.086226	0.086303	0.000898
12	0.084154	0.0754	29.846	0.000130	0.083943	0.084073	0.001548
22	0.082405	0.1172	29.804	0.000198	0.082083	0.082281	0.002413
32	0.080728	0.1811	29.740	0.000300	0.080239	0.080539	0.003744
42	0.079117	0.2673	29.654	0.000435	0.078411	0.078846	0.005554
52	0.077569	0.3883	29.533	0.000621	0.076563	0.077184	0.008116
62	0.076081	0.5559	29.365	0.000874	0.074667	0.075541	0.011709
72	0.074649	0.7846	29.136	0.001213	0.072690	0.073903	0.016691
82	0.073270	1.092	28.829	0.001661	0.070595	0.072256	0.023526
92	0.071940	1.501	28.420	0.002247	0.068331	0.070578	0.032877
102	0.070658	2.036	27.885	0.002999	0.065850	0.068849	0.045546
112	0.069421	2.731	27.190	0.003962	0.063085	0.067047	0.062806
122	0.068227	3.621	26.300	0.005175	0.059970	0.065145	0.086285
132	0.067073	4.750	25.171	0.006689	0.056425	0.063114	0.118548
142	0.065957	6.167	23.754	0.008562	0.052363	0.060925	0.163508
152	0.064878	7.929	21.992	0.010854	0.047686	0.058540	0.227609
162	0.063834	10.097	19.824	0.013636	0.042293	0.055929	0.322407
172	0.062822	12.749	17.172	0.016987	0.036055	0.053042	0.471146
182	0.061843	15.965	13.956	0.021000	0.028845	0.049845	0.728012
192	0.060893	19.826	10.095	0.025746	0.020545	0.046291	1.25319
202	0.059972	24.442	5.479	0.031354	0.010982	0.042336	2.85507
212	0.059079	29.921	0.000	0.037922	0.000000	0.037922	Infinite

Knowing the degree of initial saturation of the external air and the amount of moisture to be removed and also that the amount of heat to be expended in drying is equivalent to the heat required to heat the air to the temperature permissible and of maximum saturation the amount of heat necessary may be determined according to the following formula:

$$H = 1120\ Q + 63000$$

H = B. T. U. required for drying per ton of dry material. The value H is determined on the assumption that the moisture is heated from 62 degrees Fahr. to 212 degrees Fahr. and is evaporated and at that temperature the specific heat of the material is 0.21. $(2000 \times (212-62) \times .21) = 63{,}000$.

The total moisture initial plus the amount removed from the materials = Q.

$$Q = \frac{2000\,M}{100 - M}$$

Wherein M = percentage of moisture and Q = pounds of water per ton (2000 pounds) of dry material. A table of values follows.

TABLE OF VALUES

M = Percentage of moisture in material to be dried.
Q = pounds water evaporated per ton (2000 pounds) of dry material.
H = British thermal units required for drying, per ton of dry material.

M	Q	H	M	Q	H	M	Q	H
1	20.2	85,624	14	325.6	424,884	35	1,077	1,269,240
2	40.8	108,696	15	352.9	458,248	40	1,333	1,555,96C
3	61.9	130,424	16	381.0	489,720	45	1,636	1,895,320
4	83.3	156,296	17	409.6	521,752	50	2,000	2,303,000
5	105.3	180,936	18	439.0	554,680	55	2,444	2,800,280
6	127.7	206,024	19	469.1	588,392	60	3,000	3,423,000
7	150.5	231,560	20	500.0	623,000	65	3,714	4,222,680
8	173.9	257,768	21	531.6	658,392	70	4,667	5,290,040
9	197.8	284,536	22	564.1	694,792	75	6,000	6,783,00C
10	222.2	311,864	23	597.4	732,088	80	8,000	9,023,000
11	247.2	339,864	24	631.6	770,392	85	11,333	12,755,960
12	272.7	368,424	25	666.7	809,704	90	18,000	20,223,000
13	298.9	397,768	30	857.0	1,022,840	95	38,000	42,623,000

The necessary heat required may also be determined according to the following data and table:

$$\text{Density of air} + .04\%\ CO_2 = \frac{001293052}{1 + .00367 \times \text{Temp. C.}}$$

(In Kilo per cubic meter)

Density of water vapor = .62186 × density of air. Density at partial pressure divided by density at 760 M.M. = partial pressure divided by 760 M.M. and specific heat of water vapor = .475 and specific heat of air = .2375 and Kilograms per cubic meter × .62428 = pounds per cubic foot.

Weight 1 cubic meter dry air

$$K_1 = \frac{001252}{1 + 1t} \quad \frac{q\,p}{760}$$

in which K_1 = weight of air in kilos, t is temperature in centigrade, p atmospheric pressure in kilos per square metre (10336) and q is partial pressure supported by air alone and e is coeffi-

cient of expansion of air (.003665). For any other barometric height than 760 mark $\frac{p_1 - q}{760}$ (10336).

If we denote $r = .2375$ specific heat of air and $S = .4755$ specific heat of water vapor and C_n = heat in calories utilized in heating the material and evaporating the water,

$$C_n = (1_r + 1_{da}\,S)\ (t_l - t_n)$$

W = weight of moisture withdrawn.

$$W = 1\ (d_n - da)$$

$$1 = \frac{w}{(dn - da)}$$

d_n = vapor in 1 kilo air leaving drying room.
da = vapor in 1 kilo air entering drying room.

$$C_n = \frac{w}{(dn - da)}\ (r + da\ S)\ (t_l - t_n)$$

t_l = temperature air entering drying room.
t_n = temperature air leaving drying room.

$$\frac{t_l - t_n}{d_n - d_a} = \frac{C_n}{W\ (.2375 + d_a\ .475)}$$

For the evaporation of 1 kilo of water at t_n 6.40 — t_n calories are required.

$$C_n = W\ (t_n - t_u) + w\ (640 - t_n)$$
$$\text{or } C_n = W\ (640 - t_n)$$

Wherein t_n is original temperature of material to be dried.

The values d_n and t_n are unknowns but are mutually dependent; assuming that the air leaving is saturated therefore for each temperature t_n there is a corresponding value d_n.

The total heat required to heat the external air 1 from its initial temperatures ta to the highest temperature t_l and its inherent moisture in calories—

$$C_g = 1\ (.2375 + d\ .475)\ (t_l - t_a)$$

The total heat required in calories is the sum of C_n and C_g. In order that the drying may be most efficient the value of C_g should be small in proportion to C_n.

The values are expressed in the following table; the column head (Humid Heat) is defined as the B. T. U. required to raise one pound of air plus the saturated water it may contain one degree Fahrenheit when saturated at the given temperature and pressure and (Humid Volume) the volume of one pound of air when saturated at the temperature and pressure.

Temp. F.	Vapor Tension millimeters of mercury	Lbs. water vapor per lb. air.	Humid heat B.t.u.	Humid volume cubic feet.	Density, lbs. per cu. ft. at 760 millimeters		Volume in cu. ft. per lb. of	
					Dry Air	Sat'd Mix.	Dry Air	Sat'd Mix.
32	4.569	.003761	.2391	12.462	.080726	.080556	12.388	12.414
35	5.152	.0042435	.2393	12.549	.080231	.080085	12.464	12.496
40	6.264	.0050463	.2398	12.695	.079420	.079181	12.590	12.629
45	7.582	.0062670	.2403	12.843	.078641	.078348	12.718	12.763
50	9.140	.0075697	.2409	12.999	.077867	.077511	12.842	12.901
55	10.980	.0091163	.2416	13.159	.077109	.076685	12.968	13.041
60	13.138	.010939	.2425	13.326	.076363	.075865	13.095	13.180
65	15.660	.013081	.2435	13.501	.075635	.075039	13.222	13.325
70	18.595	.015597	.2447	13.683	.074921	.074219	13.348	13.471
75	22.008	.018545	.2461	13.876	.074218	.073471	13.474	13.624
80	25.965	.021998	.2478	14.081	.073531	.072644	13.600	13.777
85	30.573	.026026	.2497	14.301	.072852	.071744	13.726	13.938
90	35.774	.030718	.2519	14.539	.072189	.070894	13.852	14.106
95	41.784	.036174	.2545	14.793	.071535	.070051	13.979	14.275
100	48.679	.042116	.2575	15.071	.070894	.069179	14.106	14.455
105	56.534	.049973	.2610	15.376	.070264	.068288	14.232	14.643
110	65.459	.058613	.2651	15.711	.069647	.067383	14.358	14.840
115	75.591	.068662	.2699	16.084	.069040	.066447	14.484	15.050
120	87.010	.080402	.2755	16.499	.068443	.065477	14.611	15.272
125	99.024	.094147	.2820	16.968	.067857	.064480	14.736	15.509
130	114.437	.11022	.2896	17.499	.067380	.063449	14.863	15.761
135	130.702	.12927	.2987	18.103	.066713	.062374	14.989	16.032
140	148.885	.15150	.3093	18.800	.066156	.061255	15.116	16.325
145	169.227	.17816	.3219	19.609	.065601	.060104	15.242	16.643
150	191.860	.21005	.3371	20.559	.065154	.058865	15.368	16.993
155	216.983	.24534	.3553	21.687	.064539	.057570	15.494	17.370
160	244.803	.29553	.3776	23.045	.064016	.056218	15.621	17.788
165	275.592	.35286	.4054	24.708	.063502	.054795	15.748	18.250
170	309.593	.42756	.4405	26.790	.062997	.053305	15.874	18.761
175	347.015	.52285	.4856	29.454	.062500	.051708	16.000	19.339
180	388.121	.64942	.5458	32.967	.062015	.050035	16.126	19.987
185	433.194	.82430	.6288	37.796	.061529	.048265	16.253	20.719
190	482.668	1.00805	.7519	44.918	.061053	.046391	16.379	21.557
195	536.744	1.4994	.9494	56.302	.060588	.044405	16.505	22.521
200	595.771	2.2680	1.3147	77.304	.060127	.042308	16.631	23.638
205	660.116	4.2272	2.1562	131.028	.059674	.040075	16.758	24.954
210	730.267	15.8174	15.9148	562.054	.059228	.037323	16.884	26.796

These considerations thus far are highly theoretical, no consideration having been given to radiation losses and absorption of heat by the furnace walls and handling equipment. The fact is that a larger volume of air will be necessary and must be rapidly circulated in order to produce the desired results. To operate a drying oven at temperatures at or somewhat above the point of evaporation, 212 degrees Fahr.,

would be of no avail as the air would not be heated to the point of maximum saturation and with no provisions for draft or circulation or hasty removal of vapor laden air, the moisture might again readily condense. With increased temperature, the point of saturation increases rapidly to the point of maximum saturation for the definite temperature and pressure and with it comes a rapidly increasing vapor tension of the saturated vapor destroying the equilibrium between a liquid and its vapor and offsetting the possibility of the latter reverting to the former.

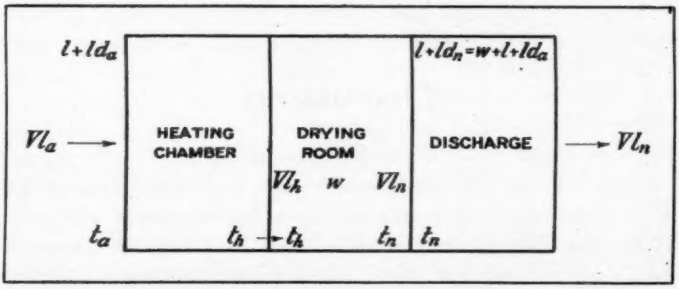


DIAGRAM SHOWING CYCLE OF AIR CHANGES

The external air is about two-thirds saturated and at the temperature of the external air is capable of taking onto itself about 50 degrees more moisture to be completely saturated. If this volume of air is heated it is possible to take on moisture to the limit possible to the amount of the temperature at the definite pressure. This incoming air is artificially heated by the products of combustion of the desired fuel and the temperature reduced to the same permissible temperature required for drying. In the event of utilizing this system for baking cores, the temperature of the heated air and products of combustion must be high enough to melt the binder to the point of covering each grain, which is the object desired. In our present-day practice and forced production, we are operating our ovens at top notch burning or volatilizing the required amount of binder, then adding more binder and then perhaps not having either time or temperature enough to properly melt this

increased quantity of binder, with the result that the core is baked in the casting and causes increased cost and delays in our cleaning departments.

W. A. JANSSEN, *Chairman.*
F. C. HENKE
L. A. WAY
R. H. WEST

Discussion

MR. W. A. JANSSEN.—In our plant at the present time we have operating a mold drying oven based on exactly the principles described in this report. It has now been in operation for some considerable time and we are enjoying wonderful success. Previous to that a core oven was designed based on these same fundamental principles and the oven worked so efficiently that I can say to you the burners were started on Monday morning and were not touched until Saturday night closing time. This oven was one of several chambers to accommodate small, medium and large cores, so that the temperature dropped from one room to another and would be sufficient for evaporation and drying of cores consistent with their sizes.

In the mold-drying oven which we have in operation at the present time we usually light the oven about 6 or 7 o'clock at night and about 12 or 1 o'clock in the morning, the temperature is sufficient. By that time the drying and the evaporation has proceeded to a point where we can shut off the burners and allow the oven to cool sufficiently so that the molds may be withdrawn in the morning. The interesting part of this type of oven is the fact that there is not even a spark of flame present which you will agree is a most desirable thing in the

maintenance of our cars and also the saving of our flasks from heat distortion.

MR. T. S. QUINN.—May I ask where that oven is located?

MR. W. A. JANSSEN.—In Canada.

MR. T. S. QUINN.—What size is the oven, what is its capacity and what would be the approximate cost of installing one?

MR. W. A. JANSSEN.—The oven that we have I think is about 13 feet inside width and the length is about 40 feet. I refer to the mold-drying oven.

MR. A. H. JAMISON.—I notice in the second paragraph of Mr. Janssen's report the statement that it isn't a heating problem. Now, in my experience I have had one or two problems present themselves. We found in the very moist climate of New England on the seacoast that cores would very frequently not stay dry. Thoroughly baked cores would become moist after a while. It occurred to me there might be something in the baking of cores like the caramelization of sugar—that we could change the character of binder by a slightly higher temperature. Sugars and syrups do undergo an actual physical change under the influence of high temperatures. The same occurs in the core. A heat of 700 degrees Fahrenheit, would take care of the problem. I found that 350 degrees would not and that 400 degrees would not but that 550 degrees would.

MR. W. A. JANSSEN.—I should possibly have modified that statement. I meant it rather as a comparison, because I think that most of us have always been satisfied to stick up a couple of burners and let the flame play in; the more heat we got into the furnace the better we thought we were doing our work. The fact is we were quite jeopardizing our interests. The point you bring up is quite correct.

To conclude this discussion, I wish to say that at the Boston meeting, the committee on Steel Foundry Standards presented a report which was unanimously adopted covering the standardization of special sleeves, standard sleeves and graphite stoppers. Unfortunately, possibly due to the stress of commercial circumstances we have not seen fit in our own practice to adopt these standards. As a service to our

government, to ourselves and to the refractory manufacturers we would have been performing a duty had it been done. The situation has come to the point where the refractories division of the chemical section of the war industries board is about to call a meeting consisting of representatives of this committee together with the refractory manufacturers to again discuss the matter of standards. I expect this meeting will be called very shortly and we shall then be very glad to report the results to the individual steel foundries. I am prevailing on you at this time as a duty to your government and yourself in the interest of uniform product and uniform design, which will result in better delivery and quality of product, that you will see fit to adopt this standard.

The Advantages of Basic Lining for Electric Furnaces

By F. J. Ryan, Philadelphia

In the past the usual electric furnace paper has been prefaced with a short review or history of electric furnace development, enumerating the distinctive advantages of electrical apparatus over the existing types of furnace equipment such as the converter, crucible and small open-hearth furnaces.

We have witnessed in the past two years phenomenal strides in electric furnace development from standpoints of both efficiency and number of installations, and the writer, therefore, asks to be excused for presenting nothing except a brief discussion of the types of lining installed in furnace equipment, because it is his opinion that the electric furnace should now be considered as a thoroughly reliable, economical and necessary unit in connection with the average steel plant or foundry installation.

The difference commercially between the acid and basic bottom depends entirely upon the product to be produced. In other words, usual average castings, having what is known as the general characteristics of good steel, can be produced on an acid bottom at a very low cost for refractory materials if good scrap is available. If, however, rigid chemical and physical specifications have to be met and miscellaneous scrap only is available, then the basic bottom must be utilized if good steel is to be the result.

Why Acid Bottoms Were Used

Over 65 per cent of the total output of electric steel in this country previous to our entering the war was on acid bottoms. The reason for this was that electric steel was

just beginning to be recognized for its real and true value and also because there was a real scarcity of operators familiar with metallurgical conditions therefore it was safer to operate the furnace purely as a melting medium.

Two of the principal users of electric steel castings, namely the automobile and tractor manufacturers, have in the belief of the writer brought about a revolution in the methods of producing electric steel in this country. We have, of course, for some time had the advantage of expert and scientific handling of steel in the electric furnace for the tool steel industry, but the output has not been sufficient to bring about a widespread knowledge of scientific electric steel production. It remained for the automobile and tractor industries to accomplish this result.

Designers, especially in the automobile industry, have been attempting to reduce the weights necessary in castings and forgings, and to accomplish this purpose they have necessarily been compelled to create standards which could only be met by basic steel. Therefore on account of necessity, the electric steel manufacturers have been compelled to reorganize their forces and the development of basic operation has been phenomenal even since the last meeting of this association.

The writer has attended the final negotiations for many electric furnace installations and in former days it was customary for the decision relative to the purchase of one or another make of furnace to hinge entirely on whether or not one furnace consumed a few kilowatt-hours less per ton of steel or whether the refractory costs were from 50 cents to $1.75 per ton less. In the past year we have noticed a healthy tendency to keep away from placing too high a value on such figures, for it is child's play to begrudge the small additional costs that are necessary in basic operation if the ultimate product produced is increased in efficiency from 10 to 50 per cent. Take for instance the following problem.

At the present time there is a differential between *B* and *C* castings as purchased by the navy department of from 4 cents to 7 cents per pound. Using the lower figure of 4 cents, we have a difference of $80 per ton as a margin on

which to carry on the necessary basic operations to secure a result which is very simple on a basic bottom. The extra cost for basic operation would probably not exceed $15, leaving a net total profit to the purchaser of $65, but of more importance is the saving in weight and the use of cheaper raw materials. It will be seen that if a given weight of casting is based upon certain chemical and physical properties and by metallurgical manipulation the same weight of material can be increased in efficiency 20 per cent, the ultimate body weight can then be reduced 20 per cent without injury to the original requirements.

An Eye to the Future

In the plant of one of the largest automobile manufacturers in the world there has recently been installed a small electric furnace solely for the testing and establishment of classifications of different types of steels for after-the-war consumption. The managers of this plant have secured the best technical knowledge available and their sole and one purpose is to develop the highest practicable grade of steel that it is possible to produce. Close records of all of the results are being kept and the producer in the future faces the problem of meeting such specifications if he expects to obtain any tonnage.

This is one of the many instances that have come up especially during the past year. In fact, the question of working to specifications and having the ultimate product subject to inspection has become second nature to us on account of the many government contracts which are spread about all over the country. Many of us have probably not had time to consider what this will mean in the future, but we probably will be willing to admit that there is little likelihood that we will ever return to the hit-and-miss method that was quite general in the past. Recollect for instance the many large and supposedly up-to-date plants that were producing electric steel entirely by the fracture observation method. In some instances the question of carbon was handled by the supermelting of the electrode for a certain number of moments in the molten bath and the question of

deoxidation was looked upon as one of the necessary evils to be talked about and then forgotten.

Furnace Must Be Properly Designed

Every electric furnace design is not suitable for basic operation. The ideal furnace is one which exposes the largest possible surface of the metal to the action of the slag without being subject to freezing conditions at any part of the furnace. Where the arc or arcs are centralized in the center of the furnace it is necessary to cut down the surface exposed to the slag, thereby deepening the bath. This deepening of the bath in the average furnace has a tendency to cause segregation on account of the heavier alloys which are used, such as tungsten and chrome.

The ideal condition in the application of heat is, of course, the supplying of correct proportions above and below the bath. Many methods and designs have originated from inventors attempting to secure this ideal condition, but it was not until about a little over a year ago that any definite or practical results were secured. There is now on the market here and abroad furnaces operating what might be termed as an arc resistive design and exceptional results are being obtained. It is claimed that the heat which is supplied by and in this type of furnace and the resistive action of the current passing through the hearth starts a definite convection action which very slowly stirs the molten charge doing away with segregation and causing thorough deoxidation.

In the purely top arc types of furnaces, high-grade steels are being made daily, but in such operation close attention must be given to secure a uniform product. If the heat is not distributed uniformly through the bath, segregation will be the result and if too much heat is applied, contamination of the steel by the slag is possible. Difficult as these problems may seem to the man that is now operating on an acid bottom, they can all be overcome by the use of skilled labor or by training the available staff, and the ultimate proportion of profit will be greater, also an improved reputation for the product will place the production always in demand

and the percentage of returns in poor material will be cut down to a minimum.

Scrap Will Become Scarcer

As the number of installations of electric furnaces increases, so will the available proportion of scrap decrease and with the depreciating available supply there will be a decrease in the available stock of what we might term as No. 1 low-phosphorus material and it is upon this No. 1 material that the acid operating furnaces are entirely dependent.

The government has already placed a differential on scrap that is nearly sufficient to overcome the additional cost of basic melting without even considering the additional return for the product and the cutting down of the material utilized by the increase of efficiency. In the opinion of the writer the question between basic and acid operation is purely a question of a commercial profit and loss with the advantage on the side of the basic lined furnace.

The history of every known product teaches the lesson of increase and not decrease of efficiency, and with the acid-lined furnace limited solely to one procedure of melting, it must in the course of events gradually be done away with in the electric furnace industry and be replaced by the more efficient and economical method of basic operation.

The writer realizes that the arguments brought forth in this paper nearly all pertain to the commercial aspect of the problem. He has purposely kept away from technical discussions pertaining to the actual handling of the basic and acid bottoms for the reason that we are thoroughly aware that there is now available in this country sufficient technical skill and labor to make either possible.

Every industry is entirely dependent upon the profit accruing from the sale of its product and in view of the future we must face after the war, the commercial aspect is the really important and vital side of the question that should now be considered. If this is correct, we must prepare to rearrange our plant procedure so that it may be based upon the most efficient and economical methods, but do not let it be only economical.

The Electric Furnace in the Steel Foundry

By W. E. Moore, Pittsburgh

Until about five years ago, the electric furnace in the steel foundry was practically unknown. It was generally understood that the product of the electric furnace while of the highest quality, was so costly to make that it might be considered commercially practicable only for the production of the finest tool steels, or the highest grades of alloy steel.

In the last two years, a great light has broken over the electric furnace situation for the steel foundrymen and today foundrymen are beginning to consider most favorably the electric furnace for steel foundry work, as by that process both small and moderate sized castings of intricate character can be made wherever suitable electric power is available, better, it is believed, than by any other known process. This statement will be surprising to many, but it is borne out by the records from a number of operating plants. Thus steel foundry practice only follows out the general rule that whatever can be made better by an improved process will in the end be manufactured cheaper.

Why Electric Steel Became Popular

Primarily, electric steel became popular for its superior physical properties. While such steel can be made with a more satisfactory chemical analysis, using the same grade of raw materials than by other processes, experience has abundantly demonstrated that when made to the same chemical analysis, it will average about 15 per cent greater tensile strength or ductility, depending upon its heat treatment, and is more resistant to shock and better able to re-

ceive heat treatment. The reason for this is that the steel, being made in a closed furnace and in a reducing atmosphere away from the contaminating influence of combustion gases, is more solid, freer from gases and less prone to inclusions. Being absolutely dead when properly made, and averaging lower in sulphur, electric steel is less liable to show shrinkage cracks and being more fluid it is not so liable to piping or blow holes or cold shuts.

Since electric steel can be made quite hot, a large proportion of the heat can be shanked off with less loss from skulls in the ladles. With acid electric steel it is customary to use lip-pour ladles, but when basic steel is being made, bottom tap or teapot spout ladles are generally preferred so as to prevent contact of the basic slags with the silica (acid) of the molds tending to produce blow holes.

Comparative Cost Data

The following figures show present day comparative operating costs for liquid steel in the ladle of a modern foundry at war time prices.

AVERAGE CHARGE FOR TWO TONS OF CONVERTER STEEL DIVIDED INTO FOUR CUPOLA CHARGES

Charge pounds		——Cost per ton——	
912	low phosphorus pig iron	$55.00	$22.60
912	bessemer pig iron	34.40	14.00
1816	steel scrap	30.00	24.30
360	silicon and spiegel	120.00	19.33
333	coke	10.00	1.49
	Total cost of charge for two net tons of steel		$81.72
	For one net ton of steel (plus losses 18 per cent)		49.85
Additions per ton of steel:			
10	pounds 80 per cent ferro-manganese @ 15c		1.50
6	pounds 50 per cent ferro-silicon @ 8c		.48
2	pounds aluminum		.66
	Power for blower motor		1.25
	Total cost materials and power per net ton of steel		$53.74
	Average cost of cupola and converter linings		1.20
	Labor cost		3.00
	Cost of converter steel per net ton		$57.94

ELECTRIC STEEL:

AVERAGE CHARGE FOR THREE-TON ACID LINED, HIGH POWER, RAPID TYPE, POLYPHASE ELECTRIC FOUNDRY FURNACE STEEL

Charge pounds		Price per net ton	Cost for 3 tons	Cost per net ton
6200	machine shop turnings	$19.00	$58.19	$19.39
100	mill scale	5.00	.25	.09
60	electrodes	180.00	5.40	1.80
1650	K.W.H. (550 per ton) electric power at 1c per unit		16.50	5.50
	Losses 3 per cent			.78
20	eighty per cent Fe.Mn	300.00	3.00	1.00
15	fifty per cent Fe.Si	160.00	1.20	.40
1½	pound aluminum	660.00	.50	.17
	Cost of materials and labor per ton of liquid steel			29.13
	Average cost of linings and roofs			.50
	Labor cost on furnace			2.00
	Cost per ton of electric steel in the ladle			$31.63

Acid Open-Hearth Practice

The acid open-hearth furnace is still frequently used, generally with oil fuel and mostly in foundries making the heavier classes of steel castings. With the acid open-hearth furnace the standard price must be paid for low phosphorus heavy melting scrap. The fuel oil consumption for such open-hearth furnaces in foundries usually runs from 45 to 90 gallons, costing at the present time from $3.375 to $7.50 per ton of liquid steel. In the largest of the steel foundries, it is true, producer gas is frequently used at less fuel cost. However, the contaminating effect of the sulphur content of the coal and the complications and expense of the producer plant as a rule deters the ordinary steel foundry from using coal as open-hearth fuel.

The great drawback of the open-hearth furnace is its well known inability to furnish steel sufficiently hot to satisfactorily make medium and small castings without undue costs for refractories and largely increased fuel consumption. The inconveniently large heats of the open-hearth furnace, 15 to 40 tons, count heavily against it in small casting work.

As to the most suitable type of electric furnace for installation in the ordinary steel foundry, the writer believes that basic steel will be demanded by many producers after the

war is over, who will then lower their limits of sulphur and phosphorus to a level not practicable to reach with the acid furnace using commercial grades of scrap. At present the call is for acid-lined furnaces, as present specifications are liberal as to sulphur and phosphorus content and high grade shrapnel and other munition scrap is available in large quantities. The acid furnace is simpler, cheaper and faster to operate.

It is strongly recommended that a furnace be purchased so designed and constructed that it is adaptable to basic operation. This means that the furnace shell must be of large diameter and the bath must be of large area and shallow. The furnace should not, in our judgment, be of the long arc type nor of the small diameter shell deep bath type, if the best basic work is contemplated. Indeed even for acid melting there is a noticeable difference in the quality of the steel obtained from the large diameter, shallow bath furnaces compared with that made in the deep bath type of furnace, for with the latter it is not feasible to obtain the same chemical reactions from the additions put in to refine the steel as when the bath is of the shallower type. Neither is it possible to so thoroughly deoxidize the metal by maintaining a reducing atmosphere in the furnace.

For foundry work it is especially important to have the furnace constructed with every practicable operating convenience and facility, so that one heat may follow another with the utmost rapidity and with a minimum loss of time for the necessary furnace adjustments. It is therefore important to look carefully to the facilities for making bottom and fettling the banks.

Maintenance Facilities

All practicable facilities must be at hand for maintaining the spouts, maintaining and renewing the roofs and door liners and also for convenience in adjusting the electrodes in their clamps. Suitable apparatus for switching and adjusting the currents and voltages with which it is desirable to operate during different periods of the heat also should be provided. Practically all modern furnaces are now equipped with automatic regulators, which save a large

amount of the attendant's time and do the work better than is possible with hand regulation. The very best facilities should be provided for handling the slag from the furnace and for tapping off the liquid steel. It is the opinion of the writer that the slag can best be handled by tilting down the charging door, that is tilting the furnace backward, so that the slag may be poured or raked off into a covered slag box, where its heat and presence do not interfere with and delay the operation of tapping the steel into the ladle.

It is strongly recommended that the furnace be kept as free from parts of machinery located underneath the shell as possible, for there is nothing that disgusts the operator more than to have a heat of steel cut through the furnace bottom and "gum up" a lot of gears, shafts, motors, etc. It may be argued that a cut-through of the bottom is the result of careless operation, which it certainly is, but it must be remembered that the only safe rule is that whatever can happen surely will happen sooner or later.

From the power station standpoint, which also affects the cost of the power to the user, certain important considerations must be observed. The furnace should be of such size as will enable it to be maintained in practically constant operation, as all power is now sold on a load factor basis, and the more nearly continuously a furnace can be operated, the smaller that proportion of the bill for "readiness to serve" as compared with the energy charge will become, which means that the average cost of power per unit will be less. The furnace efficiency also will be higher, which makes the saving all the more important.

It is likewise important that the furnace should be operated with the shortest possible periods between heats, for during such periods, the user loses a portion of his demand time, which would increase the readiness to serve charge. Also the furnace lining is cooling down quite rapidly and the electrodes are oxidizing away more rapidly than when melting the charge.

In some cases off peak power is available at prices which usually do not embody more than a portion, if any,

of the readiness to serve charge. In such cases it is frequently practicable to operate the furnace more cheaply during the off peak periods, such as at night, on holidays, Saturday afternoons and Sundays.

It is quite important that the furnace should operate at the highest practicable power factor which can be obtained without undue disturbance of the power company's load, for by so doing the electrode, transformer, line and generator losses are maintained at a minimum. Engineering skill of a high order is required to forecast and select the best type of equipment, under the many varied power supply conditions which obtain in different localities.

Unbalanced Loads Are Shunned

Power companies without exception dislike to receive a single phase or unbalanced load. They either refuse to handle such a load at all or penalize the user by charging a higher rate. It is, therefore, essential for furnaces above the smallest sizes, say 3/8 ton capacity or less, to be arranged to receive a balanced polyphase power supply.

It is often asked when the electric furnace field will become saturated and electric furnaces no longer desirable purchases. It is believed the natural growth of the high grade, medium and small size steel casting business will continue for years to come and demand the installation of a large number of electric furnaces.

The electric furnace is making possible the establishment of many small foundries, where heretofore the usual methods of producing steel have been too uncertain, complicated and costly. It is believed that high grade steel castings will continue to replace iron castings in increasing numbers. The tractor and truck fields provide a rapidly growing market for such castings. The railroads, tramways, agricultural implement manufacturers, machine tool builders and many other lines of industry are using steel castings in larger numbers from year to year. There is a wide field opening up for alloy steel castings of high grade that can be properly made only from electric furnace steel. Such alloy castings may advantageously be heat treated and in many cases will replace drop forgings.

Making Steel Castings on the Pacific Coast

By J. D. Fenstermacher, San Francisco.

The great development in the manufacture of steel castings on the Pacific coast is one of the most noteworthy effects of the European war. Since the beginning of this terrible conflict, the growth of the steel casting industry has been remarkable, not only from a technical but from a commercial point of view. Incidentally, the great mineral resources of the Western states were also developed. The state of California in particular is playing an important part by furnishing materials that are vitally essential to the steel industry of our country.

Steel castings are manufactured in the states of Washington, Oregon and California. The following agencies are used for melting: The crucible, the converter, and the electric, basic and open hearth furnaces. The sizes of the plants and the particular processes used for melting in each case has been determined largely by the location and class of castings required in certain communities. It would be rather difficult for me to compare the different melting practices as to their relative merits along the lines of cost and practical application. Individually, the foundryman may be able to demonstrate why his particular process is commercially satisfactory in accordance with the type of castings produced for patrons in his community. I will therefore endeavor to describe some of the general conditions that are encountered by the Pacific coast manufacturers of steel castings.

Confidence is Growing

Primarily our geographical location has placed us all in a position which has been more or less disadvantageous to the healthy growth of our business. However, from day to day, we are becoming more confident by reason of the fact that

conditions are changing rapidly and in directions that are beneficial to us. I am unable to predict miracles until great manufacturing plants that will create demands for steel castings such as you have in the East are established in our territory.

We have no gigantic establishments for building locomotives, cars, rolling-mill machinery, machine tools and many other products too numerous to mention. However, we are gradually entering this field, and today we are building locomotives, cars and machinery, not, it is true, on a scale compared with the east, but to an extent commensurate with our demands, brought about by conditions with which you are all familiar.

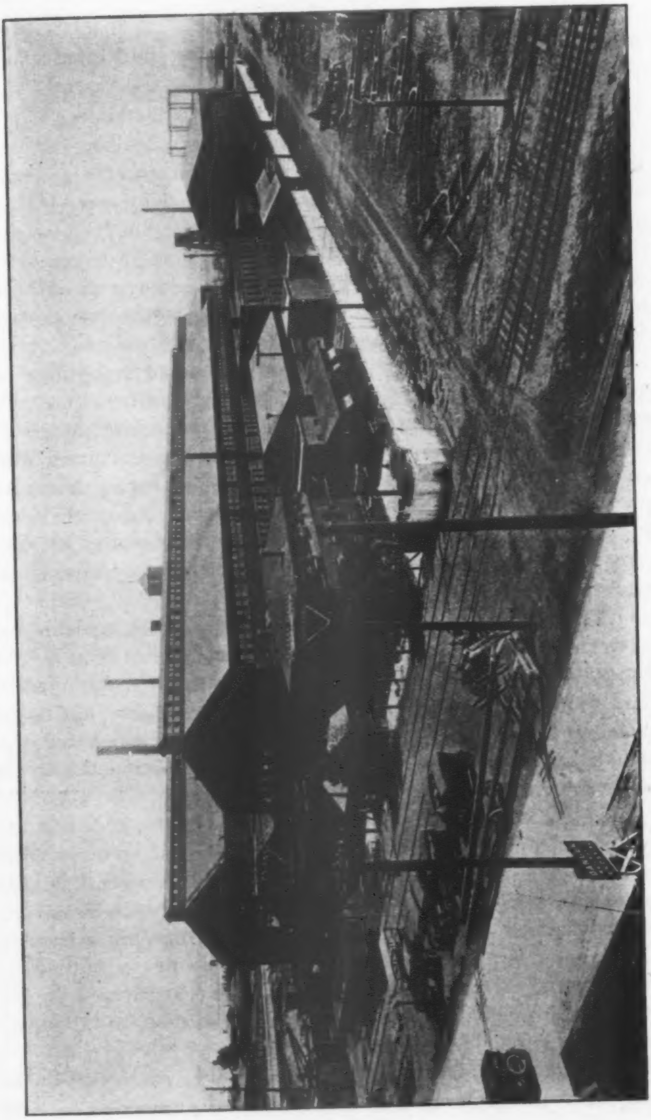
To supply and demand, prefixed mainly by immediate requirements, can be attributed to our commercial welfare, and prior to the outbreak of the present war the steel founders on the Pacific coast encountered innumerable manufacturing difficulties. Conditions are different on this coast from those that prevail in the middle west and on the Atlantic coast. In order to be successful it requires considerable experience and one must be thoroughly familiar with the peculiar operations carried on in the Pacific coast territory.

The making of steel castings on the Pacific coast is not a recent accomplishment. Some were made in 1885 in San Francisco; of course not on a large scale but of a fair quality. The concerns that made them have long ago gone into other lines of manufacture, possibly because the demand for this product was not large enough to warrant continuation on a commercial basis.

In a Pioneer Territory

The oldest and largest concern on the Pacific coast in continuous operation is the Columbia Steel Co., of San Francisco. My connection with this company dating from my arrival in California over five years ago will enable me to outline its development. During that period I have participated in the struggles incidental to the commercial operation of an open-hearth steel foundry in a pioneer territory.

I will give a brief history of the origin of this company and also its growth and manufacturing difficulties to the



PRESENT PLANT OF COLUMBIA STEEL CO., AUGUST, 1918

present time. Some of the problems mentioned will no doubt apply to all of the other steel foundries on the western coast.

In 1909 the Columbia Steel Co. was organized and took over for operation the converter steel foundry which had been started in 1902 by the Columbia Engineering Works in Portland, Oreg. This was the only active steel foundry in the northwest at that time. In the same year ground was broken for the location of a new plant at Pittsburg, Contra Costa county, California, within 50 miles of San Francisco. The plant site is on the New York slough of the San Joaquin river, which with the Sacramento river, empties into the waters of Suisun bay a short distance away. These are the two largest rivers in the state of California, flowing from the south and north respectively, both navigable to a certain extent by vessels of moderate draft. The company maintains two docks on the New York slough. There are also three other lines of transportation, the Southern Pacific, the Santa Fe and the Oakland, Antioch & Eastern railroads, the last named being electrically operated.

Experience Was a Guide

From experience gleaned in the operation of the Portland, Oregon, plant it was decided to build a plant in California with facilities which would enable the company to produce large castings commercially as well as economically. A vital problem was confronted—that of the use of pig iron. No satisfactory material of this nature being produced west of the Rocky mountains, it was necessary to transport it from eastern sources. The cost of bringing the iron from the east is a fact well worth considering. The installation of a basic open-hearth furnace was decided upon. This furnace was to make steel suitable for castings, the melting charge consisting of all scrap material, eliminating the use of pig iron. The practice proved itself a success and to this day is still in vogue.

The entire plant was erected under the personal supervision of S. T. Wellman, the well known engineer. In this connection he was assisted by D. H. Botchford, the present general manager of the company, who also supervised the initial manufacturing operations. Molds were made for the

FOUNDRY YARD WITH MAIN BUILDING ON THE LEFT AND AUXILIARY STRUCTURES ON THE RIGHT.
A GROUP OF FINISHED CASTINGS IS SHOWN IN THE FOREGROUND

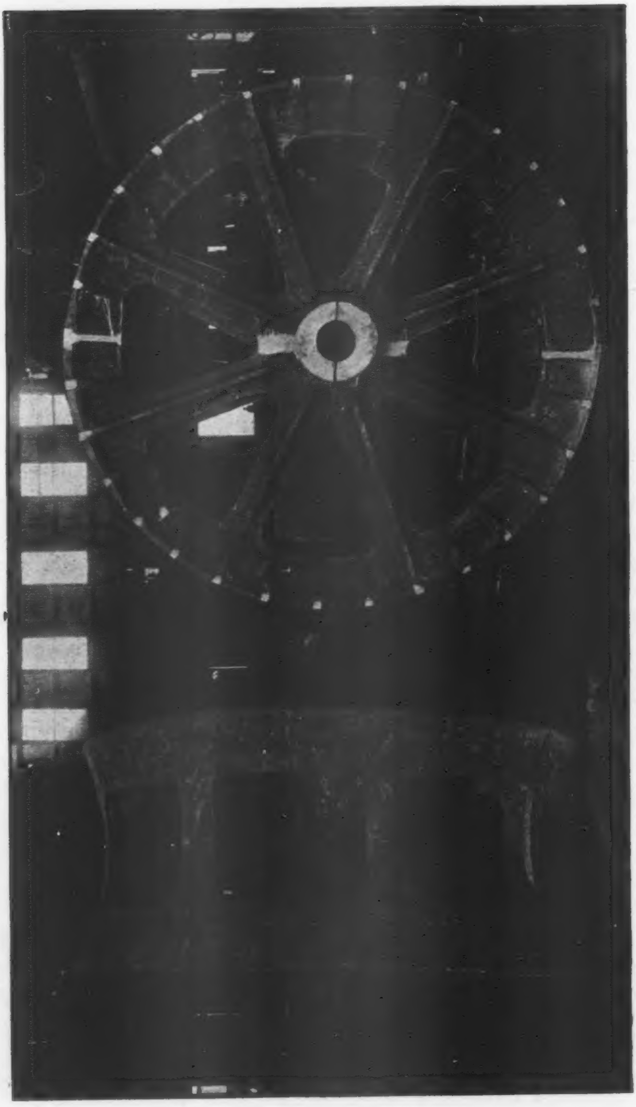
first heat which was tapped and poured successfully on Nov. 23, 1910.

I do not think it is necessary here to present a detailed description of the Pittsburg plant, inasmuch as the equipment is of a standard nature, with which all of our members are more or less familiar. This plant was described by our chairman of the Committee on Papers, his article appearing in *The Iron Trade Review* of Sept. 20, 1917, from information which he secured on a personal visit. Therefore, I will endeavor to point out some of the manufacturing difficulties experienced primarily by our isolation from the so-called centers of production, also, giving you as briefly as possible a description of what has been done to overcome some of these difficulties and the material results achieved.

Manufacturers of steel castings are confronted with a necessity for three vital things—scrap, sand and experienced mechanics. The question of scrap is being given serious consideration in the far west, not only by steel foundrymen but by the rolling mills which consume more of this material than the foundries. The present demand for scrap exceeds the production. Pig iron is being produced in very small quantities on the Pacific coast and this production is not sufficient to offset the rapidly diminishing quantity of scrap. However, steps are being taken to produce suitable pig iron locally on a large scale. This will be the solution of this vital question. California has considerable ore deposits, but coking coal has always been a drawback. Nevertheless, there are favorable indications as to the nearby source for the quantity production of suitable coke, and I hope the time is not far off when the Pacific coast will be producing enough pig iron for its own consumption.

Sand From Illinois

Next in importance is silica sand. This material is nearly all transported from Illinois. Local sands, including beach sands have been used, but they are not nearly so satisfactory as the natural eastern standards. The transportation of eastern sand is a determining factor in our manufacturing costs. I understand that certain grades of this material have been



ONE PIECE BUCKET IDLER FOR GOLD DREDGE

located in nearby states. This would lessen transportation costs and difficulties somewhat.

Suitably trained mechanics have always been scarce. The importation of this class of labor from the east has not only been expensive but has proved unsatisfactory. The only solution of this problem is for the manufacturers to train their own help. In some places this has been done to a certain extent, but all of the foundrymen on the coast cannot do so.

The absence of stable and multiple work has a great

ONE OF THE MOLDING BAYS DEVOTED TO LIGHT WORK

effect on our manufacturing costs. The reason for this has been explained in the foregoing. It is very essential, therefore, that the jobbing shop must be provided with mechanics that have a wide experience on all kinds of work, and flask equipment must be varied and flexible. It may also be necessary to use considerable wooden flask equipment according to the nature of the work, and the community in which the shop is located.

The melting stock used at the present time in the basic furnace at the Columbia plant is obtained locally from railroads, mines, smelters, gold dredges, oil fields and shipyards. Scrap

brake shoes are considered good material, but are not always obtainable. Clean steel turnings are used in small quantities. The melting is done by oil fuel exclusively. This material is delivered by barges to the company's dock and pumped into storage tanks. Facilities are such that delivery can also be made by tank cars, if emergencies demand. Either steam or air is used for atomizing.

Analysis of Raw Materials

The magnetite iron ore, limestone, dolomite and calcined magnesite are all secured from nearby sources. The following typical analyses herewith will show the quality of these materials.

	Per Cent
Magnetite—	
Silica	4.0
Iron Oxide	90.0
Limestone—	
Silica	0.2
Iron and Alumina	0.2
Calcium Carbonate	99.5
Dolomite—	
Silica	0.2
Iron and Alumina	0.3
Calcium Carbonate	55.7
Magnesium Carbonate	43.8
Magnesite—	
Silica	6.0
Iron and Alumina	5.0
Lime	1.0
Magnesia	88.0

Standard ferromanganese and ferrochrome are produced by nearby electric smelters. Fifty per cent ferrosilicon, nickel, vanadium and other alloys are obtained from eastern manufacturers.

Magnesite and chrome brick are also transported from regular eastern sources. The freight charges on all this material has its influence on operating costs, which causes the foundrymen considerable concern.

In order to convey an intelligent idea of the quality of steel for castings, to meet any recognized specifications, made from

the basic all-scrap charged furnace, the following chemical and physical characteristics are given:

BASIC OPEN-HEARTH STEEL CASTINGS MADE FOR GOVERNMENT

Heat No.	Elastic Limit lbs. per sq. in.	Tensile Strength lbs. per sq. in.	Elongat'n in 2 in.	Reduction of area	Carb.	Sil.	Analysis Sul.	Phos	Mang.
			Per Cent						
47	35,000	70,000	0.31	0.54	0.26	0.30	0.029	0.015	0.59
58	33,000	64,000	0.32	0.60	0.20	0.36	0.030	0.015	0.55
66	34,500	68,500	0.30	0.56	0.25	0.32	0.038	0.018	0.62
79	33,600	67,200	0.32	0.58	0.25	0.28	0.038	0.019	0.63
93	32,000	62,000	0.35	0.68	0.21	0.34	0.040	0.013	0.68
95	36,000	66,400	0.30	0.60	0.23	0.33	0.039	0.018	0.74
96	32,500	63,000	0.33	0.60	0.23	0.33	0.039	0.018	0.74
100	33,000	66,000	0.31	0.56	0.22	0.34	0.026	0.015	0.57
125	38,500	75,500	0.25	0.50	0.28	0.30	0.040	0.015	0.53
146	33,600	64,800	0.28	0.60	0.24	0.31	0.029	0.014	0.58
150	32,000	60,800	0.35	0.63	0.18	0.32	0.026	0.013	0.62
154	55,000	94,500	0.25	0.54	0.30	0.25	0.028	0.013	0.53*
160	31,000	60,500	0.36	0.64	0.19	0.33	0.031	0.018	0.58

*Nickel, 2.70 per cent.

Acid Open-Hearth Furnace

During 1916 increased demands for tonnage were great enough to warrant additional melting facilities. It was decided to install an acid open-hearth furnace. One of medium size was considered necessary in order to produce metal in fair quantities during periods that the basic furnace was shut down for major repairs. These repairs are more frequent for this furnace than the average basic furnace that uses scrap and pig iron. However, in spite of the severe service imposed by melting all scrap, an average of 370 heats has been produced. The last run was the best ever made, when 411 heats were turned out before it was necessary to rebuild the furnace.

The acid furnace was built to melt the foundry scrap produced by the basic furnace. Chemical characteristics of this scrap are given in the foregoing table showing material made for castings by the basic furnace. About 90 to 92 per cent of this scrap is used, the balance being made up of standard low-phosphorus pig iron. When the furnace is used for making heats to pour medium and small castings, the heats average about four tons each. This furnace has been operated continuously since last summer, and to date over a

thousand heats have been melted. Analyses of the steel made by this process for castings are as follows:

ACID OPEN-HEARTH STEEL CASTINGS MADE FOR GOVERNMENT

Heat No.	Elastic Limit lbs.per sq. in.	Tensile Strength lbs.per sq. in.	Elon-gat'n in 2 in.	Reduc-tion of area	Carb.	Sil.	Analysis Sul.	Phos	Mang.
			Per Cent						
560	36,000	70,000	0.31	0.51	0.28	0.30	0.041	0.035	0.57
564	31,500	61,000	0.32	0.56	0.21	0.24	0.043	0.035	0.66
571	31,500	60,500	0.30	0.50	0.20	0.33	0.043	0.039	0.48
582	35,000	69,000	0.29	0.52	0.28	0.28	0.044	0.036	0.61
642	32,000	65,000	0.32	0.51	0.21	0.31	0.034	0.036	0.70
707	36,500	70,500	0.29	0.52	0.28	0.36	0.034	0.027	0.65
710	36,000	68,300	0.27	0.53	0.27	0.27	0.040	0.029	0.57
730	40,000	76,500	0.27	0.46	0.31	0.30	0.034	0.016	0.67
738	32,500	62,000	0.28	0.53	0.21	0.26	0.036	0.033	0.56
741	41,000	78,500	0.26	0.49	0.35	0.29	0.038	0.024	0.73
752	37,000	72,500	0.30	0.57	0.30	0.33	0.044	0.041	0.64
758	50,000	91,000	0.23	0.48	0.43	0.30	0.039	0.040	0.59

All the steel foundries on the Pacific coast are called upon to produce a great variety of castings up to the limit of their melting capacity, but the Columbia Steel Co., being the largest manufacturer west of the Rocky mountains, is called upon to make some very large castings. However, recently this company has had inquiries for castings beyond its present melting capacity. Inasmuch as this situation has developed, the management has authorized the installation of another basic furnace. This will give the Pittsburg plant three furnaces.

Export Demand Developing

Seattle, Portland, San Francisco, Oakland, Los Angeles and smaller ports on the Pacific coast have all shown a phenomenal growth due to export demands from across the Pacific. This not only creates an outlet for goods produced locally but will take care of material transported overland for exportation from our various ports.

Discussion—Steel Castings on the Pacific Coast

Mr. E. F. Cone.—I would like to ask Mr. Fenstermacher whether he has found any difficulty in producing good steel using only scrap and the carbon residue from the distillation of petroleum. The reason for asking this question is that previously it has been considered impossible to make first class steel from old steel because it had been considered necessary to use what is termed virgin metal or pig iron in the charge.

Mr. Fenstermacher.—That is the reason I gave those physical characteristics. We don't have any trouble when making castings and I presume similar success is being achieved in the middle west. We are not experiencing any difficulty. Practically every heat of our steel must pass the requirements of the American Society for Testing Materials or the United States navy.

Captain Swanson.—I would like to ask if you have any bottom trouble?

Mr. Fenstermacher.—No, sir. We use dolomite on the bottom. At one time we couldn't get magnesite so we used all dolomite. We didn't burn it either.

The Chairman.—I think we realize that there has been quite a change in our industry in the past year. At the Boston meeting I recall there was a good deal of discussion in reference to making ordnance steel. There doesn't seem to be as much difficulty this year, which would indicate a good deal of progress in the industry. There will be a good deal of progress between now and next year. My personal opinion of the government specifications is that the enforcement of them has been a good thing for the industry. I think we are all making a better steel now than we made a year ago and the hope is that next year we will be making even better steel.

Report of A. F. A. Committee on Specifications for Malleable Iron Castings

The committee on specifications for malleable iron castings appointed to co-operate with a similar committee of the American Society for Testing Materials begs leave to report as follows:

No regular meeting of the American Foundrymen's association committee has been held during the interval that has passed since the last American Foundrymen's association convention. The reason for this was twofold.

First, permission was being sought from the officials of the American Society for Testing Materials to create a new committee on malleable iron castings that would not be part of, or attached to any other committee, as was the case when it was a subcommittee of committee A-3 on cast iron and finished castings, it being the belief of many that the industry would be better served, that more would be accomplished and greater interest aroused if such permission were granted. It was consequently deemed best to wait the outcome of this request and not to hold a meeting until it was definitely known with whom we were to co-operate. While the movement referred to was started some months before the June meeting of the American Society for Testing Materials some time passed before it was definitely known that favorable action had been taken, and then co-operation could not well take place for the reason that effective organization of the new committee was not to be brought about until the June meeting of the American Society for Testing Materials.

Second, it was deemed best to carry on the business of the committee through correspondence this year, as every-

one connected with the committee was exceedingly busy due to the exigencies of present conditions.

Organization Effected

At the June meeting of the American Society for Testing Materials organization of committee A-7 on malleable iron castings was effected and a new tentative specification adopted, in which the transverse test has been omitted, and in which inspection is facilitated.

The omission of the transverse tests was recommended, in part to simplify the specification, and in part because at the time an insufficient number of transverse tests had been made, so we were unable to be sure that there would exist no danger of adopting data incompatible with the tensile requirements, or vice versa.

Inspection is facilitated, because castings are now accepted or rejected based on annealing oven charges instead of air furnace heats.

A copy of the new American Society for Testing Materials tentative specification was sent to each member of our committee with reasons given in detail for the changes that had been recommended, with the request to voice an opinion in and finally to vote for or against the recommendation that they be adopted by the American Foundrymen's association at the October meeting. All votes were cast in favor of this recommendation. A copy of the tentative specifications as adopted by the American Society for Testing Materials is attached herewith.

Enrique Touceda, *Chairman.*
W. G. Kranz.
F. E. Nulsen.
H. E. Hammer.

A. S. T. M. and A. F. A. Tentative Specifications for Malleable Castings

(Railroad; Motor Vehicle; Agricultural Implement, and General Machinery Castings.)

I—Manufacture

1. The castings shall be produced by either the air furnace, open-hearth, or electric furnace process.

II—Physical Properties and Tests

2. Tension test specimens, specified in Section 4 shall conform to the following minimum requirements as to tensile properties:

Tensile strength, pounds per square inch.....	45,000
Elongation in 2 inches, per cent..............	7.5

3. (a) All castings, if of sufficient size, shall have cast thereon test lugs of a size proportional to the thickness of the casting but not exceeding ⅝ x ¾-inch in cross section.

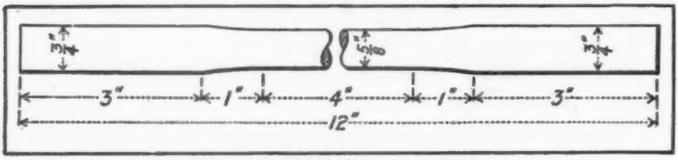


FIG. 1—TENSION TEST BAR

On castings which are 24 inches or over in length a test lug shall be cast near each end.

These test lugs shall be attached to the casting at such a point as will not interfere with the assembling of the castings, and may be broken off by the inspector.

(b) If the purchaser or his representative so desires, a casting may be tested to destruction, which should show good tough malleable iron.

4. Tension tests specimens shall be of the form and dimensions shown in Fig. 1. Specimens whose mean diameter at the smallest section is less than 19-32-inch will not be accepted for tests.

5. A set of three tension test specimens shall be cast from each heat without chills, using heavy risers of suffi-

cient height to insure sound bars, and suitably marked to insure identification with that heat. Each set of specimens so cast, shall be placed in some one oven containing castings to be annealed.

After annealing, three tension test specimens shall be selected by the inspector as representing the castings in the oven from which these specimens are taken.

If the first tension specimen conforms to the specified requirements, or if, in the event of failure of the first specimen, the second and third tension specimens conform to the requirements, then the castings in that oven shall be accepted, except that any casting may be rejected if its test lug shows that it has not been properly annealed. The failure of either the second or third test specimen shall reject the entire content of the oven.

Any casting rejected for insufficient anneal may be re-annealed once. The re-annealed casting shall be inspected and if the remaining test lugs, or castings broken as specimens, show the castings to be thoroughly annealed, they shall be accepted; if not, they shall be finally rejected.

III—Workmanship and Finish

6. The castings shall conform substantially to the patterns or drawings furnished by the purchaser, and also to gages which may be specified in individual cases. The castings shall be made in a workmanlike manner. A variation of 1/8-inch per foot will be permitted.

7. The castings shall be free from injurious defects.

IV—Markings

8. All castings, if of sufficient size, shall have cast on them the manufacturers' identification mark, as well as the pattern numbers assigned by the purchaser, these markings being so located as not to interfere with the service of the casting.

V—Inspection and Rejection

9. The inspector representing the purchaser shall have free entry at all times while the purchaser's contract is being executed, to all parts of the manufacturers' works which concern the production of the castings ordered.

The inspector shall be afforded free of cost all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications.

10. Unless otherwise agreed to, all tests and inspection shall be made at the place of manufacture prior to shipment, and in a manner that will not interfere with the operations at the plant.

11. The manufacturer shall be required to keep a record of each melt from which castings are produced, showing tensile strength and elongation of test bars cast from such melts. These records shall be available and shown to the inspector whenever required.

12. Castings which show injurious defects subsequent to their acceptance at the manufacturers' works may be rejected, and, if rejected, shall be replaced by the manufacturer free of charge to the purchaser.

The Annealing of Malleable Castings

By A. E. White and R. S. Archer, Detroit

The work leading to the preparation of the following paper was done at the chemical engineering laboratories of the University of Michigan. The experiments were performed by Robert S. Archer, holder of the fellowship in metallurgy established by the Detroit Edison Co., with the assistance in a very general way, of C. F. Hirshfeld, chief of research, of the Detroit Edison Co., and the writer. The authors also wish to express their appreciation of the advice of Professor E. D. Campbell, of the University of Michigan, during the conduct of the work.

Although this paper is presented under the joint name of White and Archer, the writer wishes to point out that his other duties kept him from assisting in only an advisory manner, as the work proper and also the preparation of this paper were largely the efforts of Robert S. Archer.

(Signed) A. E. White.

The heating cycle employed for the annealing of malleable castings varies considerably among the different foundries, even when the same grades of white or "hard" iron are used. The reasons assigned by the annealers for their particular variations of the process are often obscure. This is only natural when it is considered that their sources of information lie, for the most part, in accumulated traditions and in workshop experiments carried out in furnaces with uneven temperature distribution and, until recently, poor means for measuring temperatures.

The present investigation was not undertaken, however, with any idea of showing the practical annealer how to produce good malleable, for as in so many other branches of metallurgical practice, the art has developed ahead of the science. The purpose was rather to throw such light on the metallurgical principles involved that the same grade of work might be produced with greater efficiency as to annealing time and uniformity of product.

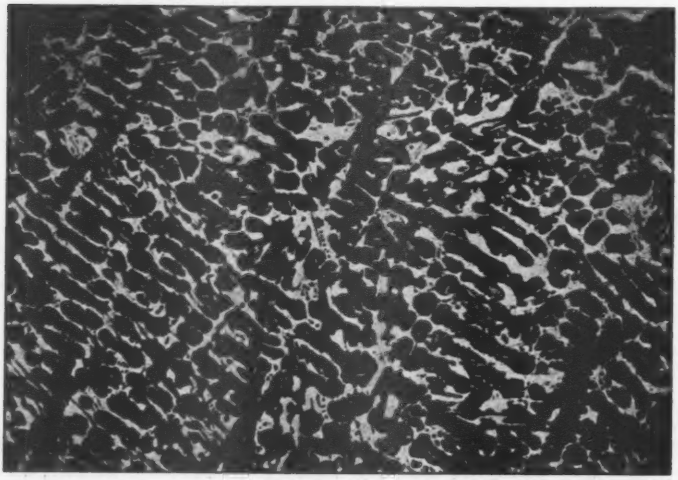


FIG. 1—WHITE IRON, ETCHED NITRIC ACID. MAGNIFIED 100 DIAMETERS.

FIG. 2—WHITE IRON, ETCHED NITRIC ACID. MAGNIFIED 1000 DIAMETERS

Before proceeding with the results of the present work, a brief discussion of the composition properties and constitution of malleable castings is presented.

The proper composition of good white iron castings for malleable is indicated by the following limits:

	——Per Cent——	
Combined Carbon	2.60	3.00
Graphitic Carbon	none	...
Silicon	0.45	1.10
Manganese	0.25	0.40
Phosphorus	under	0.225
Sulphur	under	0.06

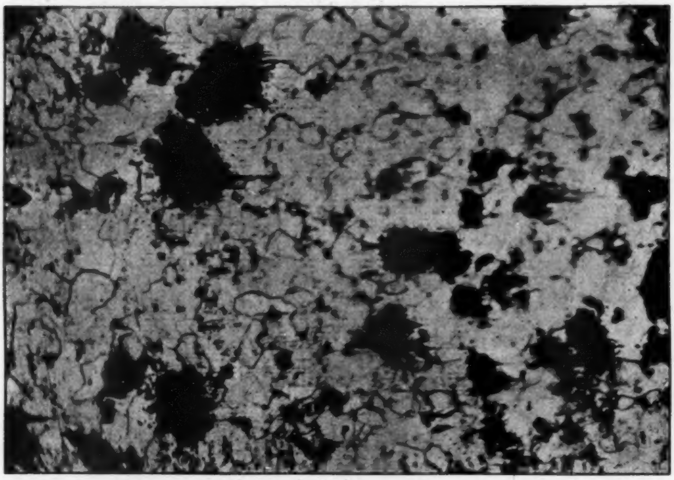


FIG. 3—COMMERCIAL MALLEABLE ETCHED IN NITRIC ACID. MAGNIFIED 100 DIAMETERS

On annealing no chemical change takes place except the conversion of combined carbon to graphitic carbon and a slight reduction of total carbon by oxidation.

The change in constitution is shown in the photomicrographs, Figs. 1, 2 and 3. Figs. 1 and 2 show sections of the white iron used in these experiments. The micro-constituents are cementite (white) and pearlite (dark in Fig. 1, and laminated in Fig. 2). Fig. 3 shows a specimen of a commercial malleable of similar composition and thickness of section. The black areas are graphitic carbon in the form characteristic

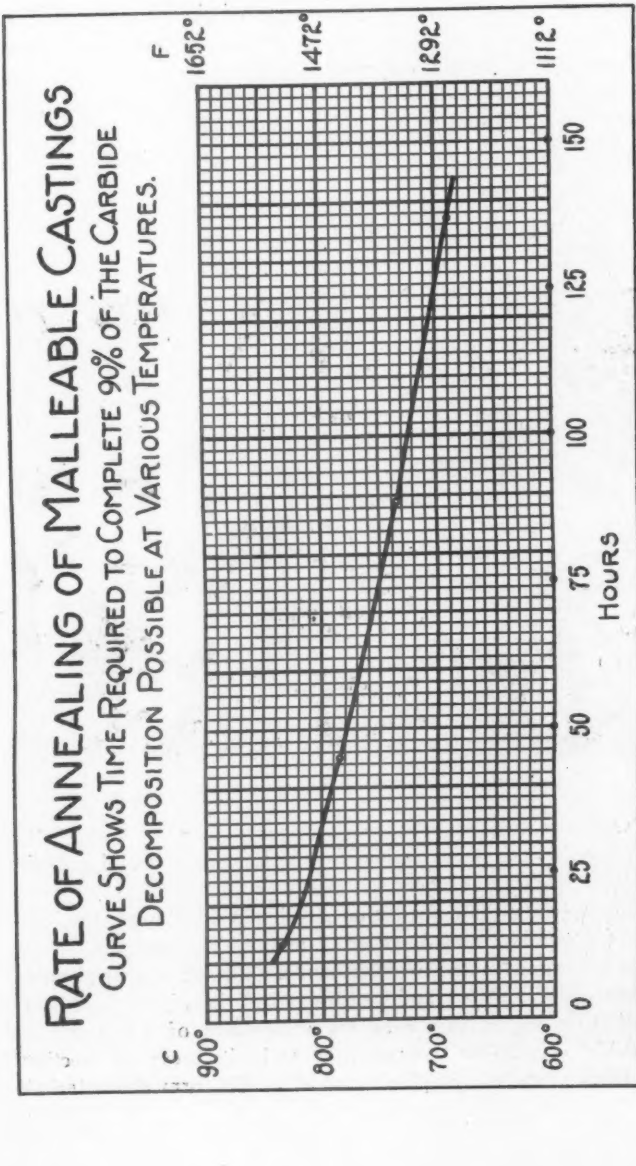


FIG. 4—RATE OF ANNEALING OF MALLEABLE CASTINGS.

of malleable, in which form it is known as "temper carbon" or "annealing carbon". The softening of the casting by annealing is due to the elimination of the hard and brittle cementite.

As to physical properties, malleable occupies a place between gray iron and steel. The tensile strength varies from 35,000 to 60,000 pounds per square inch and elongation from 3 to 10 per cent. The authors recall a test in which the tensile strength was 52,000 pounds per square inch and the elongation 28 per cent. This ductility is, of course, unusual. The transverse strength on a 1-inch square bar on a span of 12 inches is from 3,000 to 5,000 pounds with a deflection of ½-inch to 2½ inches.

Experimental

The present experiments were carried out with one particular grade of white iron. The analysis of the material was as follows:

	Per Cent
Combined Carbon	2.90
Graphitic Carbon	none
Silicon	1.05
Manganese	0.35
Sulphur	0.035
Phosphorus	0.11

This metal was melted in an air furnace and cast from a single ladle into sections ⅜-inch thick. The annealing experiments were carried out in a wire wound electric furnace, using a calibrated platinum-platinum rhodium thermocouple for temperature measurements. The rate of annealing was measured by the decrease in the percentage of combined carbon, as determined by difference between total and graphitic carbon. The results of the various treatments were followed by microscopic examination.

The commercial annealing cycle may be said to consist roughly of three stages: Bringing to heat; holding at heat; cooling. Practical men usually insist on a slow heating, a low annealing temperature, and a very slow cooling. The reason for the slow heating appears particularly obscure; and, while it is well known that a fairly low annealing temperature is necessary for the production of good malleable, and that

slow cooling is necessary to avoid hard castings, the exact limits in these respects appear to be in some doubt. It was hoped, therefore, to clear up some of the following points:

Effect of rate of heating.
Maximum permissible annealing temperature.
Time necessary at this temperature.
Necessary rate of cooling.
Temperature below which the rate of cooling is immaterial.

The first of these questions to be considered was that of the time necessary to complete annealing at various annealing temperatures. Samples of white iron were brought rapidly to heat and held for various lengths of time, followed by quick cooling. Drillings were then taken and analyzed for combined carbon. On heating at a given temperature for various lengths of time, the percentage of combined carbon gradually decreases and finally becomes constant. This constant value depends upon the annealing temperature, and, for any temperatures used in practice, varies from about 0.75 to 1.00 per cent, increasing with the temperature. If the annealing temperature is below the A_1 point, which is at 1365 degrees Fahr. for the iron used in these experiments, the combined carbon is completely decomposed.

The time required to reach such equilibrium conditions at any given temperature cannot be determined exactly, because the rate of decomposition of the combined carbon becomes very slow as the end of the process is approached. The time required to complete 90 per cent of the process at any temperature can, however, be determined within about 10 per cent. The curve shown in Fig. 4 shows the time required to complete 90 per cent of the decomposition of combined carbon possible at the various temperatures in question.

Since it is impossible completely to anneal a white iron, that is, to change all the carbon to the graphitic form, above the critical temperature, 1365 degrees Fahr., the annealing must always be completed below this temperature. In practice this is done by cooling slowly through the range immediately below critical. It was found that cooling at the rate of 20 degrees Fahr. per hour through the critical range and down to about 1200 degrees Fahr. was sufficient to complete the annealing.

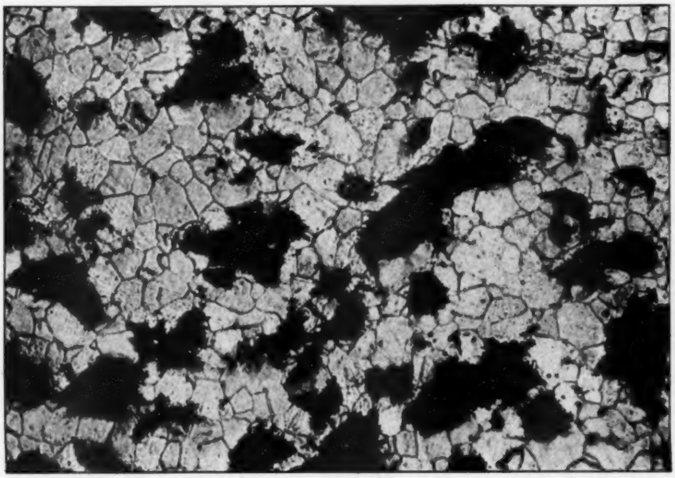


FIG. 5—NITRIC ACID ETCH. MAGNIFIED 100 DIAMETERS

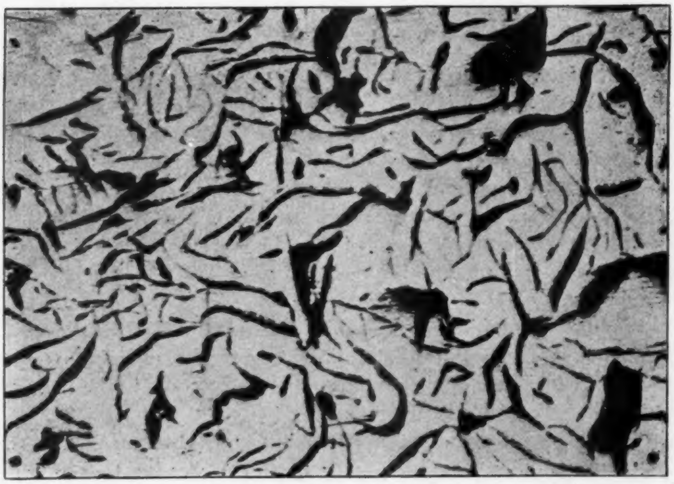


FIG. 6—GRAY CAST IRON UNETCHED. MAGNIFIED 100 DIAMETERS

With this information it was possible to plan annealing treatments of wide variations as to time and temperature, with reasonably certain results, as far as the elimination of combined carbon was concerned. Thus a white iron could be completely annealed by heating at 1275 degrees Fahr. for eight days, or the combined carbon could be completely eliminated in a few hours by a short, high heat, followed by a slow cooling through the critical range. Fig. 5 is a photomicrograph of a sample annealed by holding two hours at 1800 degrees Fahr., cooling through the critical, and holding for five hours between 1300 degrees and 1350 degrees Fahr. The total time in the furnace was eight hours.

Up to this point in the work, the only consideration had been annealing from the chemical point of view, that is, the sole object had been to eliminate combined carbon. It was, of course, realized that the possible variations in annealing treatments were limited both by the necessity for producing good malleable castings and by the inflexibility of the large furnaces used in the malleable foundry. It was known in a general way that the use of excessively high annealing temperatures in practice was fatal to the production of good malleable, as well as causing undue destruction of annealing pots and furnace arches. The authors were not, however, aware of any strictly metallurgical reason why a casting, properly packed to prevent oxidation and warping, should show inferior physical properties because of annealing at a high temperature. Experiments were therefore made to determine the effect of annealing temperatures upon physical properties. For these experiments the white iron was cast in the shape of the test bar recommended by the American Society for Testing Materials. The composition was similar to that already quoted.

It was found that the physical properties deteriorated with increase in annealing temperature. The elongation was most affected, although, as has often been noted, the tensile strength fell with the elongation.

Microscopic examination of the annealed specimens showed the cause of this difference in properties to be due to a difference in the forms of graphitic carbon, or temper carbon, pro-

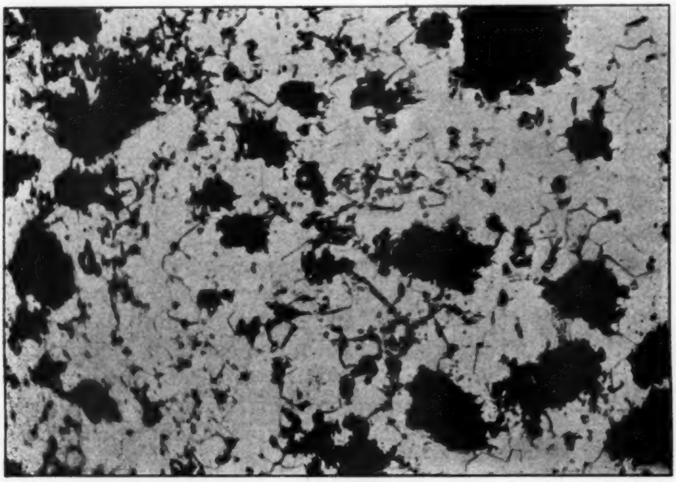


FIG. 7—COMMERCIAL MALLEABLES NITRIC ACID ETCH. MAGNIFIED 100 DIAMETERS

FIG. 8—ANNEALED AT 2050 DEGREES FAHR. UNETCHED. MAGNIFIED 100 DIAMETERS

duced at the various annealing temperatures. Fig. 6 is a photomicrograph of a piece of gray cast iron. The constituents are the same as those of an annealed malleable; graphitic carbon in a matrix of impure iron known metallographically as ferrite. Fig. 7 shows a sample of commercial malleable. The particles of temper carbon are in a rounded form, so that they do not break up the continuity of the metallic matrix. This form of graphitic carbon is considered quite distinct from that of the gray or mottled iron casting. It was noticed, however, that in some of the annealed test bars which showed poor physical properties, the form of the temper carbon approached in places the flaky form of the graphite of gray iron. This was thought to be caused by too high an annealing temperature. To verify this, samples were heated at various temperatures with the results shown in Figs. 8, 9, 10, 11 and 12. These samples from the original lot of metal cast from the same ladle. The form of the graphitic carbon is seen to change in an entirely gradual and continuous manner from the flake form of the gray iron casting to the rounded form characteristic of good malleable. It is clear that the physical properties of annealed castings will likewise vary continuously from those of a gray iron casting to those of good malleable, according to the annealing temperature. The danger from high annealing temperatures has, then, a real metallurgical foundation, quite aside from the difficulties incidental to annealing room practice. The upper limiting temperature to be used in annealing is, of course, not sharply defined. It will vary, for a given white iron, according to the physical properties desired in the finished malleable.

Practical Annealing Treatments

The possibilities in the way of annealing treatments carried out in small laboratory furnaces are almost unlimited. Malleable castings can be produced of any desired quality consistent with the composition and quality of the original hard iron. The annealing time can be varied, as has been shown, from eight hours to eight days, the shorter time resulting in general in an inferior malleable. The anneal of eight hours can probably be even further reduced and still produce a casting in which the combined carbon is completely eliminated. It is also possible considerably to shorten the usual annealing periods and

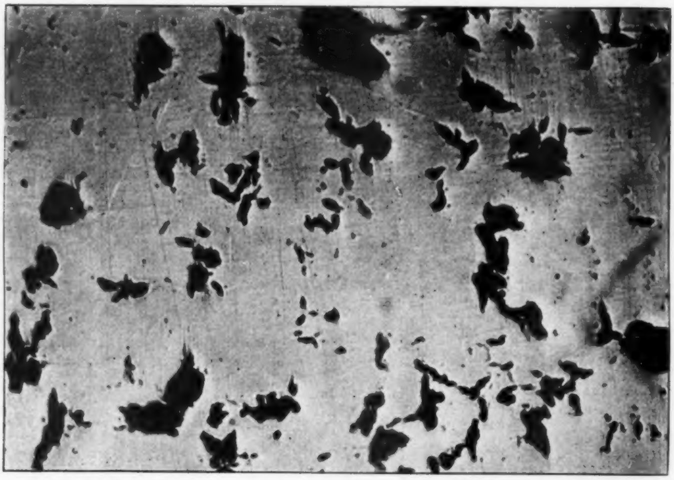


FIG. 9—ANNEALED AT 1950 DEGREES FAHR. UNETCHED. MAGNIFIED 100 DIAMETERS

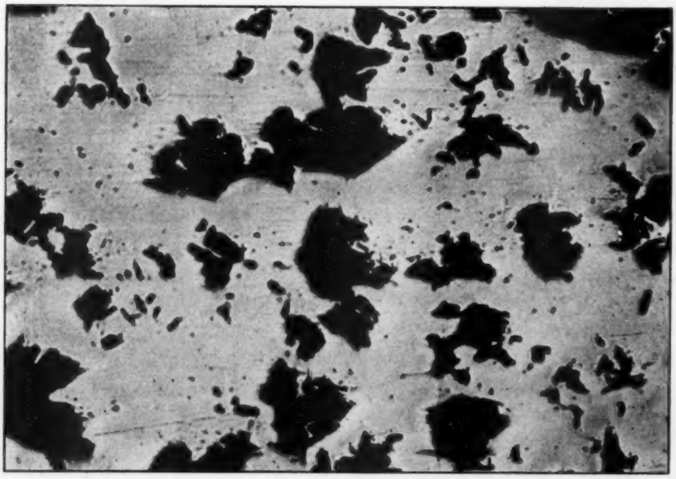


FIG. 10—ANNEALED AT 1800 DEGREES FAHR. UNETCHED. MAGNIFIED 100 DIAMETERS

at the same time produce the highest quality of malleable, by processes involving comparatively rapid temperature changes. The authors have not, however, devoted much attention to such processes, because of their commercial impracticability. It has been considered that the annealing of malleable castings is necessarily a tonnage proposition, and that annealing treatments must be fairly simple, involving slow changes of temperature. It has therefore been attempted to apply the results of these experiments to the usual commercial practice.

Annealing treatments may be divided into two general classes; those conducted entirely below the critical temperature, and those in which the critical temperature is at some time exceeded.

The first type is simple. The white iron castings are heated to a temperature between 1250 degrees Fahr. and 1375 degrees Fahr., and held at that temperature until annealing is complete. The time necessary to hold at heat depends upon the exact temperature, and the nature of the original hard iron. The curve presented earlier in this paper indicates the time required at various temperatures for the particular grade of iron used. It is evident that the rates of heating and cooling are without any metallurgical effect, and depend only upon the practical considerations of the annealing room. This type of treatment is the slowest and may be expected to produce castings whose physical properties are as good as can be produced from the same white iron by any other process. The one exception to this statement that occurs to the authors is in connection with hard spots, which will be referred to later.

The second type of treatment, that is, in which the critical temperature is at some time exceeded, has many more variations. These must all have one feature in common. After cooling below the critical temperature, the castings must be held immediately below that temperature long enough to convert about 0.70 per cent of combined carbon to graphitic carbon. This is, of course, accomplished by cooling slowly to about 1250 degrees Fahr., or lower. The most rapid rate of cooling possible for a given casting will depend somewhat upon the temperature at which it is withdrawn from the furnace. That is, the slow cooling merely affords an opportunity for a reac-

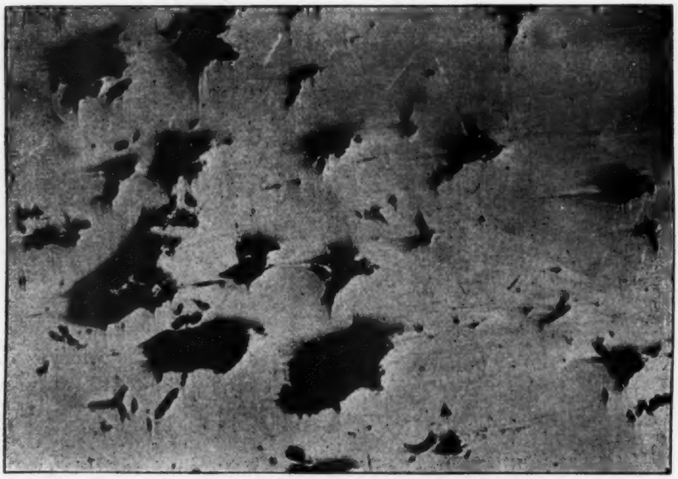


FIG. 11—ANNEALED AT 1700 DEGREES FAHR. UNETCHED. MAGNIFIED 100 DIAMETERS

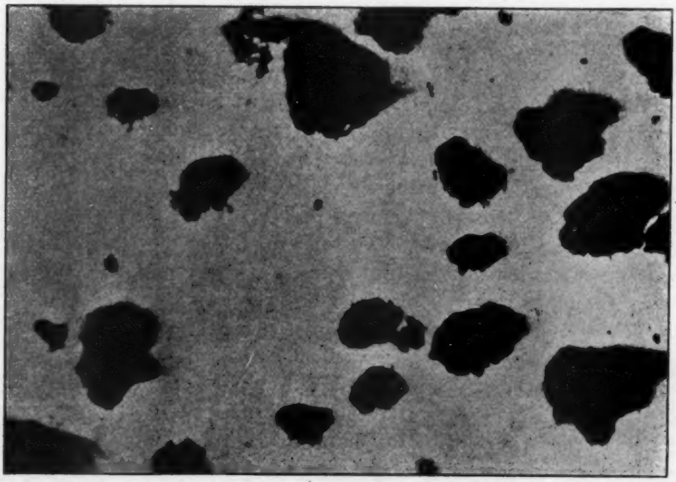


FIG. 12—ANNEALED AT 1275 DEGREES FAHR. UNETCHED. MAGNIFIED 100 DIAMETERS

tion to take place which occurs at all temperatures between the critical and about 1250 degrees Fahr. with appreciable rapidity. It is evident that, the higher the temperature at which the furnace is opened, the slower must be the cooling before opening.

On the other hand, the much discussed question as to the highest temperature at which a furnace can be opened without producing hard castings depends on the rate of cooling preceding. Theoretically, the casting might be withdrawn at 10 degrees below the critical, provided it had been held in that 10-degree range for some four or five hours. Such temperature control is, of course, impracticable in commercial work. Close attention to pyrometer equipment is required to measure temperatures within 10 degrees Fahr., and the temperature variations in a large oven may easily be 50 degrees Fahr. It may therefore be said that even in a well controlled oven, the temperatures of the various castings may differ 60 degrees Fahr. from the reading indicated by the pyrometer. In some ovens this divergence rises to 200 degrees Fahr. Hence no definite temperature for opening the oven can be set, even when the rate of cooling is fixed. In general, it may be said that it is safe, for the grade of iron here considered, to cool at a rate of 15 degrees Fahr. per hour from the critical temperature down to 1260 degrees Fahr. minus the greatest possible divergence of actual temperature from indicated temperature. Thus, if this divergence is held to 60 degrees Fahr., the furnace can be opened at a temperature of 1200 degrees Fahr., as indicated by the pyrometer.

Returning now to the first part of the annealing process, let us consider the rate of bringing up to heat. This stage of the process, up to the critical temperature, is identical with the corresponding stage of processes of the first type—that is, in which the annealing is conducted entirely below the critical temperature. The temper carbon produced is of the well rounded form conducive to the highest physical properties.

Let us suppose that the heating has been so slow that only about 0.75 per cent of combined carbon is left by the time the critical temperature is reached. On passing through and above the critical temperature, no further formation of temper

carbon will take place, and, presumably, the properties of the casting will not be injured unless the temperature becomes excessively high. Then on cooling slowly through the critical this remaining combined carbon will be converted to graphitic carbon.

Two things are gained by raising the temperature above the critical. First. the elimination of this remaining 0.75 per cent combined carbon is accomplished in a much shorter time than if the annealing is completed below critical. It was found that to eliminate the last 0.75 per cent of combined carbon when annealing entirely below critical required two to three days, whereas the same amount could be converted to graphitic carbon by slow cooling from above critical in five to seven hours. The second advantage of heating above critical is that hard spots such as caused by segregation of manganese or sulphur, are broken down much more readily than at the lower temperatures, thus reducing one of the consumer's greatest troubles.

The process just described and discussed may be said to produce malleable quite as good as that produced by annealing at a low temperature, and with a considerable saving in time. Any other annealing treatment of the second type may be considered as an inferior variation of this one. Thus, the period of bringing up to the critical temperature may be so short as to leave, say 2.0 per cent of the carbon in the combined form. On heating above the critical some 1.0 per cent of temper carbon is then produced, of a form which is more injurious to the properties of the casting as the temperature of formation is higher. Time is saved by the use of higher temperatures, but at the expense of quality.

In conclusion, the authors wish to say that they do not believe that there is any such thing as an ideal heating cycle for the annealing of malleable castings. The best treatment to use in any particular case must depend on local conditions and on the purpose for which the malleable is produced. For example, in many cases machinability is more important than a high percentage of elongation. If so, a high temperature may be used to advantage. Each case must be considered individually, and it is hoped that in such consideration the results here presented may be of some use.

Discussion—The Annealing of Malleable Castings

Mr. H. A. Schwartz.—Mr. Archer's work rather largely overlaps certain experiments made by the company with which I am connected and which were scattered over the past few years. The work we did was along the lines outlined in the paper just submitted. Material of constant composition was annealed under various temperatures and times. It is well also to indorse the method by which Mr. Archer approached his subject by eliminating all considerations as to the packing material. Graphitization being purely a process going on within the iron itself is dependent only upon the composition of the iron, and in no sense upon the nature of the packing by which the material may be surrounded.

I would further second what Mr. Archer has said as to the difference in shape of the free carbon, according to whether it grew at a high temperature or a low. The reason for this difference in shape is, of course, associated with the degree of solidity of the medium in which the carbon grows. If the carbon is trying to grow in practically a liquid, it can expand and grow to any shape or size it pleases. If it has its birth in a solid, the solid solution around it impedes its growth and in place of spreading out, it curls up.

Accordingly, the results found by Mr. Archer are entirely in accord with what they should be—that there is an actual continuous change of form of free carbon beginning with the temper form formed at the critical point and ending with graphite crystals formed within 10 or 15 degrees below the melting point.

With one of the points brought out in Mr. Archer's paper I must take issue; that is, assuming that I have correctly understood him. He says that if you hold a piece of white cast iron at a temperature just above the critical point, approaching this point as closely as may be but not reaching

it, the limit of the graphitizing reaction will be reached when there remains behind in the metal 0.8 per cent of carbon in the combined form. In other words, that the reaction ceases when the metallic matrix is of the eutectoid composition.

It is, of course, well known that the solubility of carbon as cementite decreases with the temperature, being approximately 1.70 per cent at the melting point and approximately 0.89 per cent at the critical point. In our opinion, however, the limit of the graphitization is not the solubility curve of carbon as cementite, but the solubility curve as carbon in the free state. It is known that carbon in the stable system (iron carbon) is less soluble than carbon in the metastable system (iron cementite). Just what the form is of this solubility curve is not known. I think, however, that the curve begins at 1.70 per cent at the melting point, and decreases to zero at the critical point. The equilibrium conditions of the system iron carbon are those which governed the end of the reaction in annealing, for there finally remains only iron and carbon in the system when the last combined carbon has been graphitized. Indeed it was my view that the potential of this reaction was furnished by the fact that carbon was more soluble as cementite than it was in the free state.

The method of work we adopted was to determine the combined carbon remaining in a given metal after various times at various temperatures. The data for any one temperature were then plotted as a curve showing the relation between combined carbon and the time of the heat treatment. These curves, in general, start out as a straight line parallel to the time ordinate for a short distance, then drop off more or less speedily, and finally turn again parallel to the time ordinate, that is, to a constant value for combined carbon. The limiting value so reached depends upon the temperature and is less, the lower the temperature. We plotted these curves for a string of temperatures and, as might be expected, it is shown that the equilibrium is approached much more slowly the nearer the temperature is to the critical point. An inspection of the limiting value so reached led us to believe that the solubility would be zero at the critical point.

It develops also, of course, that as the reaction approaches completion its rate decreases to such an extent, due to the small amount of carbon remaining undecomposed, as to make it slower than the reaction at a lower temperature, at which the condition would be farther from equilibrium. There is, therefore, a certain limit to the reaction at each temperature beyond which time will be gained by decreasing the temperature to increase the speed of reaction.

We plotted a curve of this nature, and in actual practice were able to anneal very rapidly by following the indications of this curve. In every case our times to obtain equilibrium were longer than those given by Mr. Archer. For this discrepancy we have at the moment no explanation. We thought we had shown that the time required for complete graphitization varied inversely as the temperature above the critical point; that is, the curve was a hyperbola. We really built our ideas on that assumption rather than on the actual observation, the observations being close to the assumptions, however. Working in that way, I think we got the annealing time down to possibly 72 or 80 hours. It is true that the rate at which you heat is unimportant. We found incidentally that commercially you could not heat to 1500 degrees fast enough to cause any graphitization below this temperature, and that under commercial conditions graphitization does not begin until this temperature is reached by the metal.

In agreement with Mr. Archer's figures, we were aware that graphitization continued at temperatures somewhat below the critical point. Furthermore, the formation of temper carbon will grow slower and slower until the rate of reaction becomes infinitely slow at complete graphitization and, therefore, this condition cannot theoretically be reached. The graphitizing reaction increases rapidly with the presence of silicon and the presence of several other elements, and it can be retarded almost indefinitely by the addition of elements which hinder the annealing process. Incidentally, it might be of interest to say that we have never found an alloy that contained carbon in the usual amount that you could not graphitize if you stayed long enough at the proper temperature.

PROF. ENRIQUE TOUCEDA.—I would like to ask you what your definition of a flake is.

MR. R. S. ARCHER.—It has the appearance of a fish scale.

PROF. ENRIQUE TOUCEDA.—That isn't the manner in which the graphitic carbon exists in gray iron or in malleable iron. As a matter of fact, it is chunk, no matter in what way the section of the iron is cut. While it always appears as a flake, that is positive proof that it is a chunk and not a flake. I object seriously to the use of the word "flake" wholly on the ground that it is misleading to the foundrymen and they get the idea it is just a thin fish scale deposit in the iron instead of being, as it really is, a solid chunk. Do I understand that in the case of a white iron heated to above the critical range the carbon becomes graphitic?

MR. R. S. ARCHER.—That is right.

PROF. ENRIQUE TOUCEDA.—Then you must assume that austenite is gamma in which carbon is dissolved rather than Fe_3C.

Some of the Factors in the Manufacture of High Grade Malleable Castings

By J. G. Garrard, Milwaukee.

Malleable iron castings have always been known to their users as castings possessing ductility, but many of these same users think they should never be made with heavy sections due to their false belief that the castings cannot be annealed through. This idea is still in the minds of men who have been using malleable castings for years. Every effort should be used to correct this impression and convince them that heavy sections can be thoroughly annealed.

This contention; coupled with poor design of patterns, is the greatest difficulty the malleable foundryman has to go up against. I have seen failures of malleable castings where the user has changed to steel, and in comparing the malleable patterns with those for steel, you would not know they were for the same purpose. The steel sections are always increased and ribs eliminated for the purpose of reducing shrinkage, whereas the failure of most malleable castings can be eliminated by changing the design. Abundant evidence is available to prove that good malleable castings can be used in place of steel.

The Secret of Annealing Heavy Sections

There is more or less of a trick connected with making castings with heavy sections. First, you must get the metal high enough without too great a reduction in carbon, it being a known fact that carbon oxidizes much more rapidly than silicon and can be readily identified in the test piece by the short crystals. This condition with the silicon under 0.50 per cent

cannot possibly give good results. The metal, however, can be changed in the furnace with the addition of low-silicon pig iron to increase the carbon.

Gating with heavy shrinkers and close attention to the ribs on any particular casting is very important. Chills can be eliminated in most cases and should be as they do not correct the trouble but simply drive the shrinkage from one place to another.

We have experimented a great deal with our furnaces in reference to top blast, as it is my contention that excessive top blast not only causes more shrinkage but produces unsound and weak castings.

Top Blast Pressure Eliminated

We have adopted a method of practically eliminating pressure on the top blast and in doing this we do not have any trouble with high heats, as the firemen cannot force the heat to the extent of excess oxidation.

The blast at the tuyeres shows only two-thirds ounce, and I believe this accounts for the following results:

	—First Iron—			—Last Iron—	
Test No.	Silicon Per Cent	Total Carbon Per Cent	Test No.	Silicon Per Cent	Total Carbon Per Cent
2	0.90	2.65	2	0.90	2.51
3	1.04	2.62	3	1.04	2.61
4	1.02	2.56	4	1.00	2.49
5	0.92	2.61	5	0.95	2.59
7	0.98	2.40	7	0.99	2.42

A furnace run to turn out uniform first and last iron, annealed with the use of pyrometers to insure the proper temperatures, is bound to give a tensile strength of 45,000 pounds and over per square inch with an elongation in 2 inches of 7½ per cent and over. This is a practical material for most uses.

There has been a great deal of confidence placed in castings showing a deep skin. This skin is carbonless iron produced with strong packing which absorbs the carbon from the outside of the casting. Such a skin can be increased by more than one annealing, but it does not show any great advantage over the casting annealed without packing or in a straight cinder packing.

Discussion—Manufacturing Malleable Castings

THE CHAIRMAN, MR. J. P. PERO.—There is one question which has come to my mind in the reading of Mr. Garrard's paper, and that is whether he has not taken into consideration the relation of top blast to melting time and fuel consumption, whether the change from a relatively high to low pressure top blast has in any way affected the furnace operation?

MR. J. G. GARRARD.—I might state in that connection that when we arrived at this figure we started our experiments by shutting off top blast little by little. These experiments, to arrive at the amount of top blast to be used, were over a period of about three weeks. In fact, we kept cutting down the top blast until melting stopped. We then worked back until we got enough air and no more.

During experiments, of course, we used a lot of coal. As far as our time is concerned and the amount of fuel, now we do not use any more than with the old method.

Malleable Iron as a Material for Engineering Construction

By H. A. SCHWARTZ, Indianapolis

Iron in its various forms is no doubt the world's most valuable material of construction. It finds its application in the arts principally in two general forms, as steel and cast iron. Both these materials are very well known to the designing engineer, and he uses them freely and with confidence as their respective properties adapt them to his needs. A third form, malleable cast iron, or malleable for short, is relatively little known to him and unfortunately appears to be respected to an equally slight degree.

We are accordingly confronted with all manner of peculiar opinions regarding this product and its application to engineering projects. It is no doubt natural that the conservative engineer finally resolves any doubts as to the properties of a material with which he is unfamiliar against that material. Such a course is only good conservative practice from his point of view, but may nevertheless be a decided detriment not only to the producer of the discarded material, but also to the prospective user.

Why Engineers Object to Malleable

There are many instances where steel for example has been substituted for malleable at an increased cost and a decreased service. The objection in the engineer's mind to malleable iron seems, in the last analysis, to be twofold and to result primarily from a lack of familiarity with the product in question. These two objections are, first, the fact that he appears to be uninformed as to the physical constants and properties of the material, more particularly in a quantitative sense and, second, that he appears to lack confidence in the uniformity of the product as now manufactured and

hence doubts whether the material is dependable, even though he has access to data as to its physical properties in individual samples. It becomes necessary, therefore, for those interested in the manufacture of malleable to take such steps as may be possible to more fully acquaint the engineering profession with what malleable iron is and it is in the hope of contributing toward this end that the present paper has been prepared.

A considerable number of years ago, Dr. Henry M. Howe, then of the Columbia school of mines, began preaching the doctrine that the properties of all the iron products might be explained by regarding them as a continuous series of alloys of iron and carbon and this view has since found favor among most of the metallurgists who have had occasion to work in these fields. It may be well, therefore, to approach our subject from this viewpoint in order to explain not only what malleable iron is, but why it is, and to make clear to the technical reader, who may not, however, be versed in the details of its manufacture, the principles upon which the successful making of malleable iron depends. He can thus be shown that the manufacture of this product, while it is an extremely complex metallurgical process, nevertheless depends on certain broad generalities and laws, a knowledge of which will make possible the continuous production of a uniform product.

In the early stages of the iron industry articles which were to be made malleable, *i. e.*, hammerable, were made by the smith of wrought iron. These articles owe their malleability to the fact that wrought iron is practically pure iron. All other forms of iron contain quantities and forms of carbon which interfere with this malleable property. Alloys high in carbon, however, possess the advantage of great fusibility and are, therefore, capable of being cast in any desired form in molds, instead of being laboriously hammered into shape.

Rationale of the Malleable Process

In 1722 Reamur conceived the idea of decarburizing a high carbon casting by heating it to bright redness in iron ore. The resulting product would be a casting of practically

pure iron. This invention was the basis of the malleable industry even though the reaction upon which it is based is now but incidental to the process. Some years later, Seth Boyden, working in Newark, N. J., practiced what he supposed to be the same art which had been invented by his great French predecessor. He found, however, that the product of his operations differed generally from Reamur's product in that the material though soft and malleable was black instead of white. Unknowingly, Boyden had discovered an entirely different principle of malleablizing and continued to practice it without any understanding of the reason for his results. From Boyden's work there grew directly and indirectly the modern malleable casting industry.

In the light of scientific research, an explanation of Boyden's work is in brief as follows:

Carbon exists in iron in two chemical forms, in the free state and as a carbide called cementite. Cementite contains 6.7 per cent carbon and is soluble in both solid and molten iron. The solubility corresponds at the melting point to an alloy containing little less than 2 per cent of carbon, decreasing with the temperature until at just about 700 degrees Cent. it corresponds to an alloy containing 0.9 per cent carbon. In cooling below the critical point the solubility abruptly becomes zero.

Solid alloys, such as the foregoing, are in the metastable condition, *i. e.,* there are internal chemical forces striving to bring about rearrangement but unable to do so because they are counterbalanced by the restraining influence of low temperature. The alloy desires to attain the stable condition in which it will consist of iron and iron carbide. The solubility of carbon is less in the free state than in the form of cementite at all temperatures below the melting point. At 700 degrees Cent., the critical point, it is zero instead of being 0.9 per cent. It is a general law that any chemical reaction in a solution will proceed in the direction of formation of that one of the possible compounds which will remove itself from the solution; hence, given the opportunity, cementite will break up into iron and carbon, the latter crystallizing out of the system.

This conversion of the system of $Fe\text{-}Fe_3C$ is called graphitization. Graphitization is promoted by increased temperature and by the presence of certain other elements notably silicon, aluminum and titanium, and is hindered by the presence of manganese carbide, iron sulphide, chromium, tin and some other elements.

Gray cast iron contains very considerable amounts of carbon and silicon. Such an alloy will graphitize quite rapidly in the temperature interval extending about 30 degrees Cent. below its freezing point (1130 degrees Cent.). This carbon crystallizing out under these conditions is formed in a semiliquid mass of iron and grows into thin plates like fish scales.

Under ordinary conditions the body of the metal contains nearly 0.9 per cent combined carbon and is in effect a fairly high carbon steel. Iron containing less carbon and silicon graphitizes but very slowly and if of proper composition will show no graphite when cooled in a mold. Such iron, however, will graphitize if maintained sufficiently long at an elevated temperature. If this temperature be but little below the melting point, gray iron will be produced. If the temperature be chosen lower, say 900 or 1000 degrees Cent., the carbon will separate but being formed in a solid medium is unable to grow into scales of graphite. It then curls into approximately spherical forms and with sufficiently prolonged cooling the result is a pure iron matrix through which free carbon in globules (temper carbon) is scattered.

Black Heart Malleable

This product is modern black heart malleable made by a process very similar to Reamur's but very different in principle since no attempt is made to remove the carbon from the metal but to crystallize it out in a comparatively harmless form leaving a body of pure, and, hence, malleable iron. The similarity of this product to wrought iron is very close; both are pure iron, the temper carbon of malleable corresponding approximately to the slag inclusions of wrought iron.

In the light of what has been said, it is evident that the problem before the metallurgist is the production of a metal

which will freeze without any trace of graphite but which can be graphitized in the subsequent annealing operation. Both of these requirements are subject to well understood chemical laws; the former is one of chemical composition, pouring temperature, cooling conditions, and so on; the latter is one of chemical composition and heat treatment. In both cases they are subjects which can be and have been very thoroughly investigated by interested parties, and are conditions which can be quite accurately controlled. There is, therefore, no guesswork whatever, nor any mystery connected with the manufacture of malleable cast iron, at least by producers of the higher class; such producers understand quite clearly what they are about, what ends they desire to attain and what steps are consistent with the attainment of these ends.

There are to be sure such interruptions or variations of manufacturing technique as are inseparable from any manufacturing operation in general; even the steelmaker and iron-founder also occasionally fail in the execution of their process. Such failures do not result from ignorance or from the application of unknown and unexpected laws, but are merely errors in the execution of clearly understood processes. Nor is the malleable industry more subject to these vagaries than either of its larger and older sisters.

The problems presented to the malleable iron metallurgist are probably somewhat more complex than those engaging the attention of his coworkers in the other two fields, but are governed by the same laws and approached by the same methods which they use. So much for generalities on the manufacture of malleable.

The Iron-Carbon Alloys

We may next turn in somewhat greater detail to a recapitulation of the more essential metallurgical principles involved. All commercial iron products are essentially iron-carbon alloys and differ among themselves according to the amount and form of carbon present.

Steel contains but little carbon (around 0.25 per cent in the case of the cast material) which is all combined; white cast iron, that is unannealed malleable, contains approximately 2.6 per cent carbon, also all combined, and is much harder and

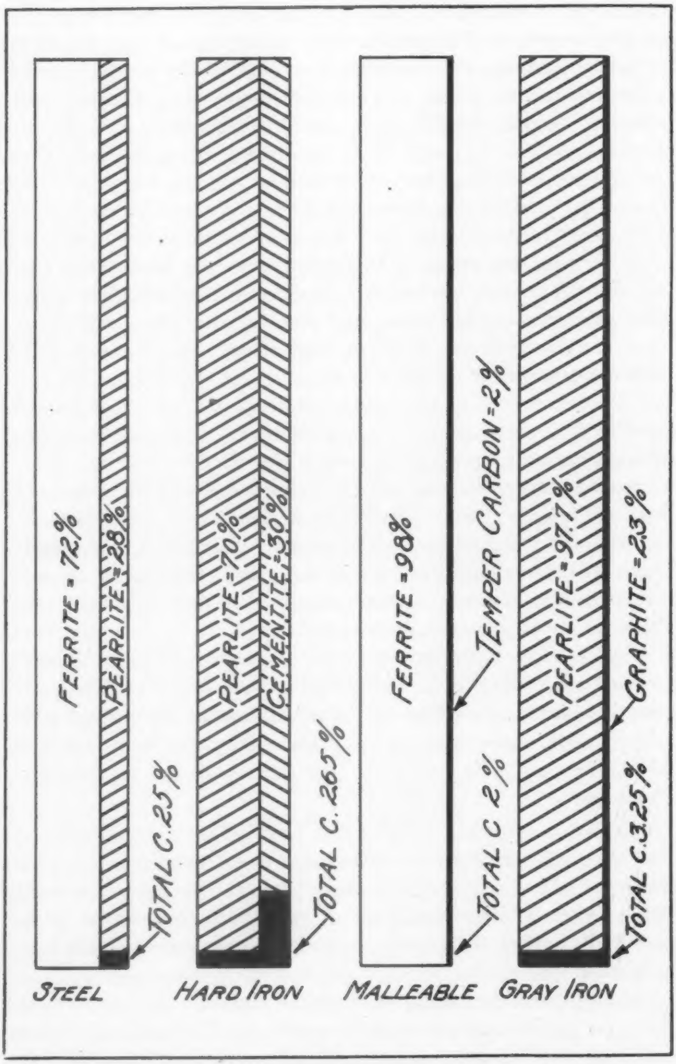


FIG. 1—AMOUNT AND DISTRIBUTION OF CARBON IN COMMON ALLOYS

more brittle than steel. When it is annealed to malleable, the carbon is somewhat reduced, say to about 2 per cent and all converted into the free state in the form called temper carbon; cast iron contains about 3¼ per cent carbon, a considerable part of which is combined, say 0.9 per cent, and the remainder in the free state, as graphite. The form in which carbon is present depends on the presence of other elements and upon

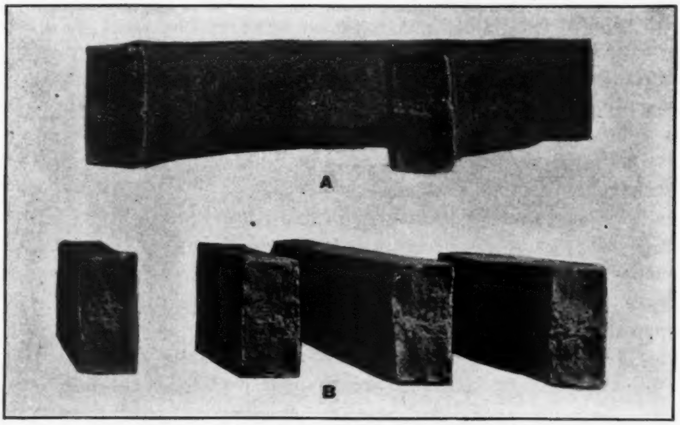


FIG. 2—FRACTURES OF MALLEABLE IRON. *A*, BROKEN BY BENDING; *B*, BROKEN BY TENSION

the heat treatment as already pointed out. In moderately slowly cooled metal, the following constituents may be expected:

Ferrite.—Pure iron, a soft, ductile metal of fair strength and great elongation resembling copper in its general physical properties.

Cementite.—A definite chemical compound of iron and carbon containing 6.7 per cent carbon; chemically it is carbide of iron Fe_3C. It is very hard, much harder than glass and very brittle.

Pearlite.—This ingredient is a mechanical mixture of ferrite and cementite of such a composition as to contain 0.9 per cent carbon. It is stronger, harder and less ductile than ferrite and is known to every one as annealed tool steel.

Temper Carbon.—Pure carbon in the amorphous or uncrystallized condition.

Graphite.—Free carbon in crystallized form.

All the irons of commerce are made up of one, two or three of the ingredients just mentioned; the low carbon steels containing less than 0.9 per cent carbon are mixtures of ferrite

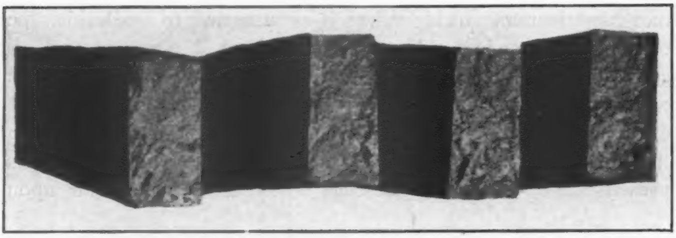


FIG. 3—FRACTURE OF WHITE IRON, BEFORE ANNEALING

and pearlite, very high carbon steels and white cast irons are mixtures of pearlite and cementite; gray iron is a mixture of graphite and pearlite, occasionally containing also either cementite or ferrite but never both; and malleable iron is a mixture of ferrite and temper carbon.

The accompanying diagram, Fig. 1, will indicate the amount and distribution of the carbon in the four types of alloys just mentioned, and the corresponding reproductions of photographs Figs. 2-5, show the appearances of the fractures of these materials.

The rectangles of Fig. 1 each representing the total 100 per cent of each material are divided by a vertical line into two divisions each, representing by their relative areas the relative amounts of each of the microscopic entities present. Each of these partial areas is divided between a white or shaded area and a black area, the line of division being such

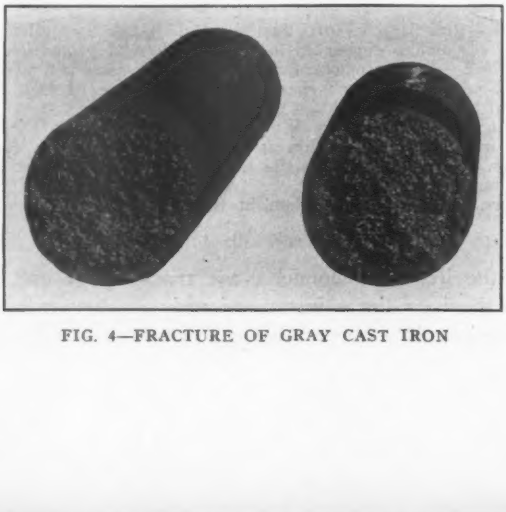


FIG. 4—FRACTURE OF GRAY CAST IRON

as to indicate the per cent of total carbon in the several microscopic constituents. The ratio of the black surface to the total rectangle then indicates the per cent of total carbon in each material.

Structure of Iron-Carbon Alloys

The character of the structure of these alloys is more clearly shown in the microphotographs. Fig. 6 is an unannealed 0.25 per cent carbon steel in which the light areas are ferrite and the grayish areas approach more or less near to being pearlite. In an annealed casting, the structure would not be nearly so coarse but the ingredients present and their relative amounts

FIG. 5—FRACTURE OF CAST STEEL

would be the same. Fig. 7 shows the structure of white cast iron in which the white areas are cementite and the gray background is pearlite. Fig. 8 is malleable cast iron in which the white background is ferrite in the form of a large number of distinct grains whose outlines can be clearly noted and the gray and black blotches are temper carbon. Please note that the temper carbon is aggregated into lumps or nodules, which are approximately globular in shape, although at this high magnification it can be seen that they are not really spherical, but merely approach this shape. Fig. 9 is a gray cast iron in which there will be seen three ingredients. There is a light one, quite probably ferrite, a gray one which is pearlite, and these two constitute a background against which are seen a series of dark gray approximately straight lines. These lines are cross-sections of crystals of graphite and the difference between temper carbon and graphite is solely that the one occurs in round masses and the other in particles suggesting in shape

the scales of a fish. It is precisely this difference in crystalline form which constitutes the essential difference between the carbon of malleable cast iron and the carbon of gray cast iron, and which accounts for the differences of physical properties of the two materials.

It will be quite obvious that weight for weight graphite will interrupt the continuity of the metallic masses through

FIG. 6—MICROSTRUCTURE OF UNANNEALED 0.25 PER CENT CARBON STEEL

which it is scattered much more than will temper carbon. Now any one of these materials has properties corresponding to the properties of the metallic matrix of which it is composed, modified by the amount of interruption that is occasioned by the free carbon which is scattered through it. The carbon has no strength and no elongation. So far as the properties of the material are concerned, it represents merely a hole in the sur-

rounding metal and of course, round holes will weaken the castings less than long narrow slots.

Characteristics of Steel and Malleable

From what has been said, we would naturally expect, and our expectations would be justified, that cast steel would be stronger than pure iron since it contains pearlite which is stronger than ferrite. For the same reason, its elongation would be less than

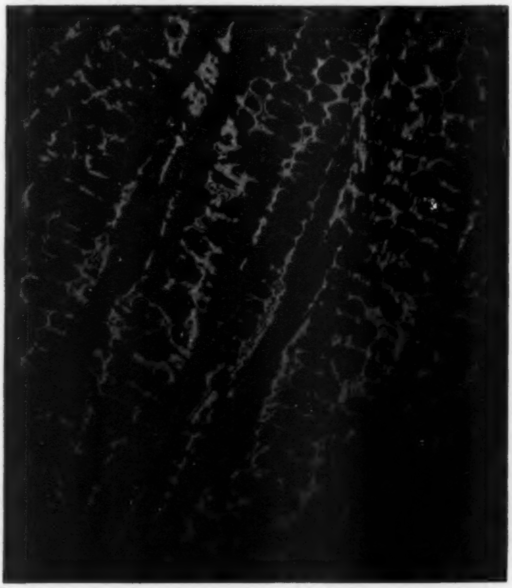


FIG. 7—MICROSTRUCTURE OF WHITE CAST IRON

that of pure iron and its strength would increase and the elongation decrease the higher the carbon of the steel casting. We would expect malleable iron to have a very fair elongation since it is made up largely of ferrite, but its elongation would probably not be as great as that of pure iron since the temper carbon will more or less interfere with this property. We would not expect malleable iron to be materially stronger than

pure iron and therefore, would expect it to be somewhat weaker than cast steel. Gray iron, we would expect to be more brittle than either malleable or steel, both because the matrix is pearlite instead of ferrite and also because the structure is much weakened by the large graphite flakes.

In Fig. 10 is shown a series of test bars illustrating the properties of the three materials. All these bars broke with a

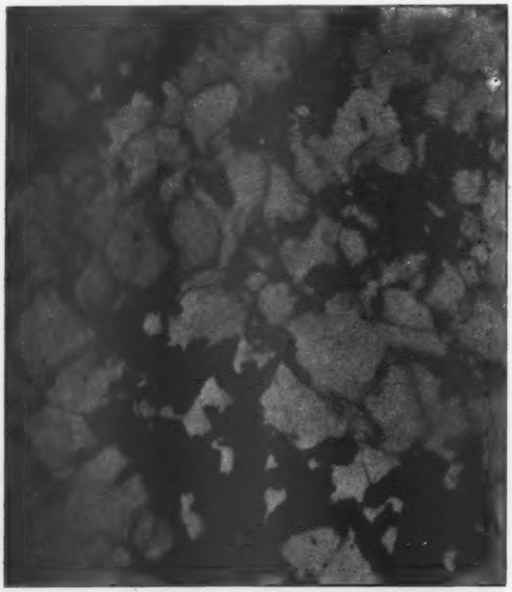


FIG. 8—MICROSTRUCTURE OF MALLEABLE CAST IRON SHOWING LARGE PROPORTION OF FERRITE

total load of 16,000 pounds; in other words, the size of the bar was chosen so that the bar should be of the same strength for each material. The upper steel bar had an ultimate strength of 68,000 pounds per square inch and an elongation of 14 per cent; the malleable bar had an ultimate strength of 48,000 pounds per square inch and an elongation of 10 per cent, and the gray iron bar a strength of 22,000 pounds per square inch and no measurable elongation. The malleable bar shown is the

American Society for Testing Materials and American Foundrymen's association standard; the two other bars were purposely made of similar shape, though neither represents the proper form of test bar for the material of which it is made.

It is quite possible that the steel bar would have shown a considerable better elongation if a suitable test piece had been

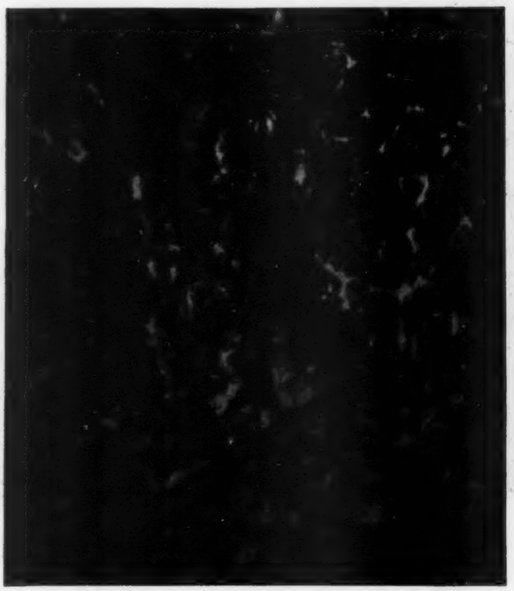


FIG. 9—MICROSTRUCTURE OF GRAY CAST IRON

used. The three bars show quite clearly, however, the relative size of bars of equal strengths made of the three materials.

Now in engineering design, it is, of course, not possible to load a structure clear up to the point of failure; indeed, the governing feature is more likely to be the elastic limit. Leaving aside certain controversies of purely engineering interest, the elastic limit might be sufficiently closely defined for the present purpose as being that load to which the material can be subjected without causing it to be visibly permanently deformed.

FIG. 10—TEST BARS ILLUSTRATING PROPERTIES OF STEEL, MALLEABLE IRON AND GRAY IRON

This point is quite generally called the yield point. In steel it is determined by a sudden drop of the testing machine beam; in malleable by the visible increase in distance between gage points on the test bar. In the following elastic limit is used in the sense of yield point.

The lower three bars in Fig. 10 are bars of the same material as are shown on the upper half of the board and are of such dimensions that they each will take a permanent set at the same figure, namely, 12,000 pounds. The elastic limits of the three materials are 46,000 pounds per square inch for the steel; 38,000 pounds for the malleable and 13,000 pounds

for the gray iron. In this connection please note that although the two malleable bars on the board are the same size, the steel bar having the same total elastic limit as the malleable bar is larger than the steel bar which has the same strength. In other words the elastic limit of malleable iron is nearer its ultimate tensile strength than that of steel. This property is exceedingly valuable in that it permits of the use of safety factors in the case of malleable iron lower than in the case of steel. The extremely low value of the gray iron indicates that this material is unsuitable in any event for loads of the character here discussed.

The Stress-Strain Diagram

The behavior of metal when subjected to tensile stress is often represented by a stress-strain diagram which plots the increase in length of the specimen compared with the corresponding loads. The accompanying diagram, Fig. 11, of malleable iron, while made before the adoption of the present

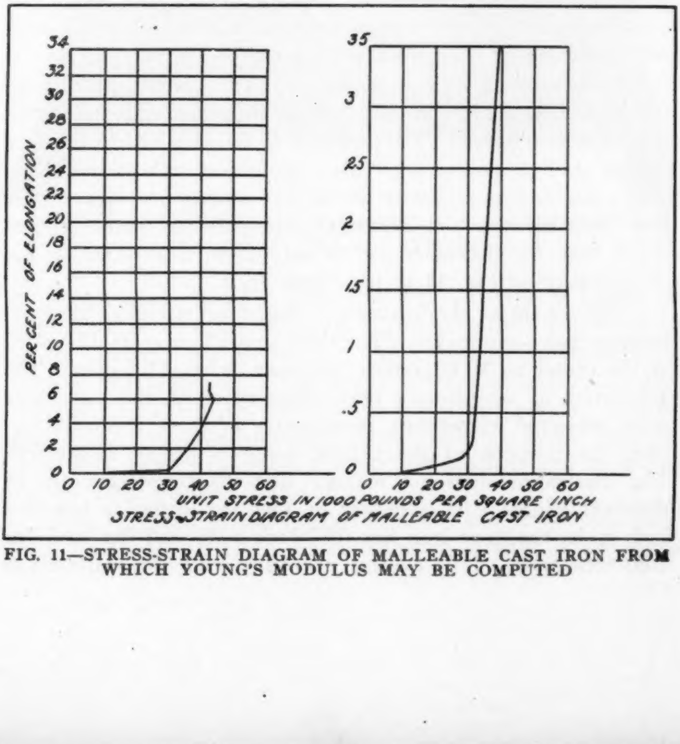


FIG. 11—STRESS-STRAIN DIAGRAM OF MALLEABLE CAST IRON FROM WHICH YOUNG'S MODULUS MAY BE COMPUTED

form of bar, will give an idea of the form of curve for this material.

It will be noted that in the small scale curve at the left, the graph is apparently straight to a point just above 30,000 pounds per square inch where it breaks sharply. This is the yield point which is quite frequently referred to as the elastic limit. Strictly speaking, of course, a material can be called elastic only when it follows Hook's law as to the proportionality of stress and strain. At higher magnifications, see the right hand graph of Fig. 11, it will be seen that the line from the origin to the 30,000-pound line is convex downward. The reproduction is somewhat imperfect below 12,000 pounds, but the fact is that under ordinary systems of measurement the graph is an inclined straight line up to about 17,000 pounds per square inch and then begins to curve more and more rapidly up to the yield point. The point where the line ceases to be straight depends largely on the precision of the observation. With sufficiently refined means of measurement, it would doubtless be found very close to zero in any material. The point where stress and strain cease to be proportional is commonly defined as the proportional limit.

From this curve can be derived the Young's modulus of the material. This constant, representing the ratio of stress to strain, is observed by experiment to be very nearly constant for all steel no matter what the composition or heat treatment. The value is approximately 29,000,000 pounds per square inch. For malleable it is also 29,000,000 for loads up to the proportional limit but decreases and is only about 16,000,000 on the curve shown in Fig. 11 at the elastic limit.

Fig. 12 shows the behavior of the three materials in cross-bending and compression. The three upper bars were all loaded at the center to 1000 pounds, the span being 12 inches. The calculation of the ultimate fiber stress to which the three bars were subjected is, perhaps, unnecessary in the present connection, the purpose of the exhibit being primarily illustrative. The illustration does not indicate that the three bars are of different widths. As a matter of fact the malleable bar is 1 inch wide, the gray iron bar 0.97 inch wide and the steel bar 0.80 inch wide. It is evident, therefore, that the malleable is

FIG. 12—BEHAVIOR OF STEEL, MALLEABLE IRON AND GRAY IRON IN CROSS BENDING AND COMPRESSION

slightly weaker than the gray iron and only 0.8 as strong as the steel bar of equal thickness. The gray iron bar, however, broke without any perceptible bend, the malleable bar has merely begun to tear in the lower surface and is not in two distinct pieces and the steel bar does not yet show any rupture but would not have stood any larger load. It could, however, have been bent considerably more before breaking had the stroke of the machine been sufficient.

On the shelf at the bottom of the board are shown samples indicating the effect of compression strains on the three

materials. All of these samples were originally ½-inch in diameter and 1 inch high. The three pieces to the left were loaded to 21,000 pounds. The one at the extreme left is steel, and has settled somewhat; the next one is malleable and has settled somewhat more and the third one is gray iron and is so badly shattered that it has to be preserved in a glass tube.

The next sample is a malleable piece which has been loaded to 23,000 pounds and has sheared through but not yet separated into two pieces. The piece at the right is steel, which was loaded to 100,000 pounds, the capacity of the machine, and has merely spread out into a pan cake.

Primarily it is to be observed on this board that the steel and malleable bars deform very much before they are actually destroyed so that articles made of these materials will not break without previous warning.

In addition to the static tests such as have been reported in connection with the samples previously shown, the properties of a material under shock are of considerable importance. These properties are not so easily illustrated as the preceding. There are two kinds of dynamic or shock stresses of interest in this connection. One of these is the effect of repeated small stresses in opposite directions and the other is the resistance to heavy blows. For the former, little data are available and no samples. It is known, however, that malleable iron on account of its microstructure resists alternating stresses of this kind very well. For the purpose of measuring the latter effect a number of tests have been devised. That which is usually applied to malleable iron is the one commonly attributed to the late J. B. Walker of the Erie Malleable Iron Co., Erie, Pa. It consists in striking the point of a wedge of standard form a series of 70 foot-pound blows until the material breaks, or until 20 blows have been struck. The reader is quite probably already sufficiently familiar with this test.

At the bottom of Fig. 13 are shown three such wedges after test. Reading from left to right these are: Steel, malleable and gray iron. The steel and malleable wedges have both been struck 20 blows and have completely curled up. The gray iron wedge has been broken off at the point by the first blow. Measurements of this kind have not yet reached

FIG. 13—UPPER PART OF BOARD SHOWS ELECTRICAL PROPERTIES OF MALLEABLE IRON, GRAY IRON AND STEEL—AT BOTTOM ARE SHOWN, FROM LEFT TO RIGHT, STEEL, MALLEABLE AND GRAY IRON WEDGES AFTER TESTING TO DEMONSTRATE RESISTANCE TO SHOCK

the point where they are quantitatively reliable but the samples here shown will serve to indicate what may be expected of the material.

Of late malleable iron is finding a considerable application in the manufacture of iron parts for electrical apparatus, notably field frames for the smaller sizes of motors and generators. Accordingly it is of importance to know the electro magnetic properties of malleable.

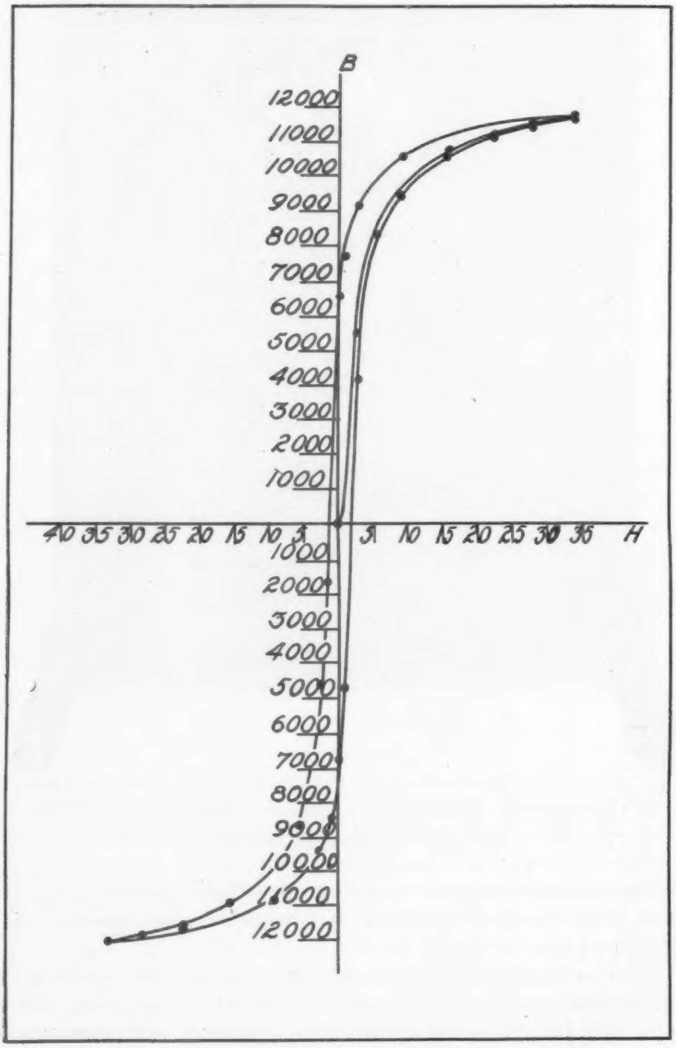


FIG. 14—MAGNETIZATION CURVE AND HYSTERISIS LOOP OF MALLEABLE IRON

The company with which the writer is connected is, so far as we know, the only malleable concern which has dealt with this subject at all thoroughly and is the only malleable foundry having at its disposal a magnetic and electrical laboratory of its own.

The writer may accordingly, perhaps, be pardoned if he refrains from a discussion of the technicalities of manufacture of malleable material especially adapted to this purpose and confines himself to a statement of results only.

Magnetic Properties of Malleable

The magnetic properties of malleable iron are very good when the material is of good quality; these properties are about as good as those of soft steel and are exceeded to an important degree only by absolutely pure iron. On the upper part of Fig. 13 will be found three paper circles indicating the cross-sections of steel, malleable iron and gray iron as marked, which will carry equal magnetic flux at saturation; in other words, a cross-section of each of the three materials of the size indicated by these circles, if magnetized to the utmost limit that the material will permit will have the same strength as a magnet for all of the three materials.

It will be seen that the malleable iron requires relatively a very small area for this purpose, much less than the gray iron and but very slightly greater than the dead soft steel.

Another point of importance in the design of electrical machinery is the matter of permeability, that is the relation between the electrical energy used in the magnet coils and the resulting strength of field. This is of importance as fixing the efficiency of the magnet and the amount of copper required for its windings. The permeability of all materials varies according to the intensity to which they are to be magnetized. Inasmuch as the flux density has to be pretty high in order to avoid excessive weight in the iron parts of electrical machinery for comparison it has been assumed that the density desired is the greatest which can commercially be obtained in cast iron.

The three coils of copper wire shown in Fig. 13 indicate the relative amounts of copper which with equal consumption of electrical energy will magnetize equal cross-sections of steel,

malleable and cast iron to this flux density. The outer coil corresponds to the cast iron, the next to malleable and the smallest to steel. The problem is, perhaps, a little complex for the nontechnical reader, but it can be readily seen that the amount of copper required for the gray iron is incomparably greater than that for either malleable or steel; as a matter of fact, it is 144 times as much as for steel and between 80 and 90 times as much as for malleable iron. For the benefit of those who may be interested in more exact data, Fig. 14 will indicate the magnetization curve and hysteresis loop of malleable iron of suitable quality for magnetic purposes.

In passing it may be well to invite attention to the spiral chip which encircles the exhibit on the board shown in Fig. 13. This is one continuous turning removed from a malleable casting. It is 24 feet long, not including the increased length due to its spiral form and it is presented here as evidence of the machining qualities of the material.

So much for a general outline of the behavior of malleable under various service conditions.

Summary of Physical Properties

For the benefit of the designing engineer, it may be most convenient to summarize the physical properties of the material in order to furnish him a basis for calculation. The figures here quoted are derived from a considerable number of tests and observations which have come to the writer's attention and err if anything on the side of conservatism. They may be taken as entirely safe for the basis of any engineering design when the material is obtained from reputable manufacturers. As a matter of fact, many of the specifications will be quite largely exceeded as a rule. The figures are as follows:

*Tensile strength, pounds per square inch	45,000
*Elongation, per cent	7½
*Ultimate fiber stress in cross-bending, pounds per square inch	64,000
Young's Modulus, for loads under the proportional limit	29,000,000
Yield point, pounds per square inch	30,000
Proportional Limit, pounds per square inch	17,000
Strength in compression, pounds per square inch	100,000
Impact Test, Charpy (sample 10 mm. square x 53.0 mm. x 3 mm, 45° V-Notch), foot pounds	7.5
Specific gravity	7.4

Brinell hardness No.	110
Scleroscope hardness No.	15
Intensity of magnetization at saturation, C. G. S. units	11,500
Permeability at this density, C. G. S. units	300
Maximum permeability (at about 6000 lines per square centimeter)	2,000
Electrical resistance, ohms per cm. cube	0.000044

*Based on A. S. T. M. specifications.

Turning next to the matter of uniformity of product, it may

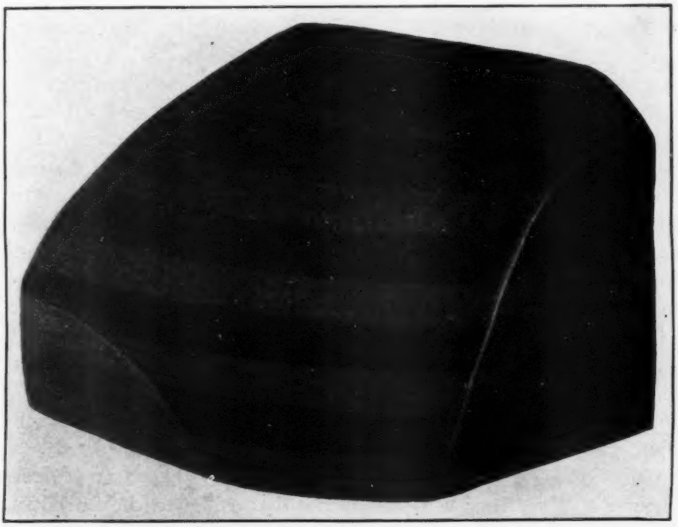


FIG. 15—MODEL ILLUSTRATING EFFECT OF VARYING PROPORTIONS OF SILICON AND CARBON ON THE STRENGTH OF MALLEABLE IRON

be well to point out to the engineer reader some generalities as to why all malleable iron is not exactly alike.

It is very unfortunate that nearly everybody expects to ask: What is the tensile strength of malleable iron, or the permeability, or whatever else may be under discussion, without an adequate understanding of the fact that malleable iron has been made of a very great variety of compositions and anneals, many of them not suited to good work. Even eliminating the

variations of compositions and heat treatment due to ignorance alone or to unexpected accidents, and not in accord with good practice, there remains the question of adapting the material furnished to the conditions required.

Variations in Properties

The properties of malleable iron vary considerably according to the quantities of carbon and silicon which it contains and it is perfectly legitimate to select carbons and silicons which in the judgment of the manufacturer are adapted to the best interests of the customer and which depend on his individual requirements. It is fortunately true that the requirements of most customers can be met by a fairly standardized product. There are, however, particular instances where owing to the peculiarities of an individual customer's requirements some advantages must be sacrificed in order to overcome what to him are greater disadvantages; thus, for instance great strength is not compatible with very small work or very intricate designs. Very great perfection of surface frequently necessitates a sacrifice in physical properties and so on. The metallurgical details of this matter need not be fully entered upon in this connection; suffice it to say that variations of strength attend variations of chemical composition and that it is the part of a skillful manufacturer of a product to maintain his chemical composition appropriate to the work he is required to furnish.

It follows from what has been said as to the effect of free carbon on the strength of a material that a high carbon product is necessarily weaker than a low-carbon product. Under certain circumstances silicon also has its effect in decreasing the strength of the material. The user might not and, indeed, should not be interested in the chemical specifications of the product furnished him but should depend upon a statement of the properties he requires in securing a product suitable to his needs.

In Fig. 15 is shown a model which will illustrate at least qualitatively the changes of strength with varying compositions of iron. In this figure the dimension of the base running upward to the left indicates variations of silicon. The dimension running upward to the right indicates variations of carbon

and the strata shown in the block indicate the tensile strength of metal of the corresponding compositions. The block represents in its entirety the whole range in which malleable could well be made. The regions in which the well informed foundrymen operate are toward the rear corner of this block.

Since the subject would have interest only to specialists, the exact scale and range of the elements need not here be entered upon. The figure will show quite plainly the enormous drop in strength corresponding to the high silicon, high carbon alloys at the near corner of the figure.

Manufacturing Methods Sound

The writer hopes that in the preceding matter he has successfully maintained his thesis that malleable iron in manufacture and use conforms to definite laws and possesses properties which commend it to the consideration of the careful designer.

There remains now for consideration the question whether or not the manufacturers of the product merit the confidence of the consuming interests in the soundness of their manufacturing methods. This question is, of course, not capable of a general answer for in this as in other lines of manufacture there may be careful and careless producers; there may exist knowledge or ignorance; skill or crudeness.

There remains the question: What steps does the reputable manufacturer take to safeguard the interests of his customers which are also, of course, his own? In the early stages of the art, through ignorance much was left to chance even in the best conducted establishments. In each plant there grew up a very small group of men who developed an almost uncanny ability to guess right and upon their guesses depended the quality of the product. These men based their guesses not on any definitely known principles but merely upon an extremely well educated power of observation and a long memory; like Providence they "moved in mysterious ways their wonders to perform", all undaunted by their profound ignorance of any metallurgical principles or even of the fact that there was such a thing as metallurgy.

Under these circumstances it is not surprising that progress was slow and the product erratic. This condition, however, need no longer prevail and practically no errors need now be made due to lack of knowledge of causes and effects.

The well conducted establishment avails itself of the services of a trained metallurgist either as a consultant or within its own organization. It sets up a system of chemical control designed to inform it of the composition of all its raw material and its product at appropriate stages of manufacture. It supervises its annealing operations by the highest type of autographic pyrometers. It maintains research facilities by which its metallurgists may inform themselves as to causes of failure and in which experimental work in pure science can be done which has bearing on any of the problems of the industry and it calls into consultation such experts in chemistry and physics as may be required to supplement the knowledge of its own staff.

Quality Has Improved

Such an organization, of course, costs money for salaries, for apparatus and material. It is, however, the safeguard of both the producer and the consumer and is the guarantee to the purchaser of quality and uniformity.

Many writers, notably Enrique Touceda, have pointed from time to time to the fact that but a few years ago much malleable was sold with a tensile strength far below 40,000 pounds per square inch and have pointed to the consistent improvement to the present 45,000 pounds, with 7½ per cent elongation which is now generally exceeded very considerably.

Mr. Touceda's figures are avowedly representative as nearly as possible of the malleable industry as a whole and not of any particular plant. In 1903 there was established under the writer's supervision the first permanently successful chemical laboratory operated by a malleable foundry. About two years were consumed perfecting the methods, and organization and in focusing attention upon the proper points. In this laboratory there are at hand analyses and tests of each heat made in the past 13 years—about 50,000 or 60,000 in all. In that time the records do not show any interval in which the product averaged as low as 40,000 pounds per square inch, the average

being between 45,000 and 46,000 pounds per square inch. Elongations are unfortunately not available but it can be said that these results were not accomplished at the expense of that property.

The writer offers this record as proof merely of what a properly controlled plant did at a time when there were no standard specifications, without any pressure from customers, in comparison with the industry as a whole when scientific supervision was not known.

A powerful force for good in the industry came into being with the formation of the American Malleable Castings association. This organization by securing Mr. Touceda's services placed at the disposal of its members professional services which would doubtless otherwise have never been available to the smaller plants. This organization has been a potent force in promoting an improvement in quality of product.

In the last few years continued research has been productive of great improvements in the plants which come under the writer's notice. Turning to more recent times the same corporation was occupied with certain ordnance work at five different plants for a period of about four months. The government specifications were those of the American Society for Testing Materials and in that time not a single heat was condemned at any of the plants for not conforming to specifications either by the government inspectors who conducted the tests or by the company's laboratories.

Now the writer submits that records such as these substantiate his contention that the manufacture of malleable can be controlled as well as any other of similar character. If the customer will design his product to conform to the physical properties previously given and will deal with any one of the many reputable manufacturers, he can be assured of as great a uniformity of product as in any similar material. With the manufacturer or the consumer who expects to do business solely at the lowest price without regard to quality and reputation, we need have no sympathy.

Discussion—Malleable Iron as an Engineering Material

Dr. Richard Moldenke.—The older men in the malleable castings industry will be considerably astonished at the statement of H. A. Schwartz, of the National Malleable Castings Co., of Indianapolis, in a paper presented before the American Foundrymen's association, that the first chemical laboratory operated by a malleable foundry was established under his supervision in 1903.

As it is but proper that claims which lack an historical basis of fact should be challenged promptly, so that published records may remain accurate for the benefit of later generations, I wish to state my own experience in the development of the art—so far as the introduction of scientific methods are concerned. I sincerely trust that other pioneers antedating 1903 may also add some data, so that their part in the advancement of the metallurgy of malleable cast iron may be duly recorded.

In 1890 I was engaged by William McConway, president of the McConway & Torley Co., of Pittsburgh, to undertake the study of the malleable castings process—he being far sighted enough to realize that the malleable process would eventually come under the control of the laboratory, as had been the case in steelmaking. Early in 1891 I established a chemical and physical laboratory at the plant for research work, and within a year had discovered the fundamental relation of silicon in mixture-making; this independent of Turner, Ledebur and other metallurgists, of whom few chemists and engineers had heard in those early days. Secrecy was the order of the day then, and the interchange of ideas among foundrymen would have been considered business suicide.

During the Chicago World's Fair, by which time I had made many researches on the chemical and physical consti-

tution of the malleable casting, the action and range of annealing processes, the operation of the open-hearth furnace for malleable, etc., it happened that the foundry superintendent was away in Chicago on his vacation and had left what proved the wrong instructions regarding the malleable mixtures in case of changes shown by the regulation test plugs. The disastrous results when 80 tons of castings began to come out of the annealing ovens daily, with fractures getting constantly "lower", can be imagined. I was called upon to take charge and bring the mixtures back to the proper point again; which I did by daily changes of a pretty radical nature in the way of lower silicon pig irons mixed with the sprues. The castings coming from the anneal proved the correctness of mixing by analysis, and—this was in 1893—from that time the malleable foundry of the McConway & Torley Co. ran on a laboratory basis. This was ten years prior to 1903.

Very soon the establishment of a laboratory at the plant in question became fairly well known to other malleable manufacturers, for the skilled operatives in Pittsburgh had come from Cleveland originally, and these as well as the foremen visited about and naturally exchanged some information. Consequently the addition of steel, malleable and even gray iron scrap to the malleable mixtures, which I used as early as 1894, spread about. It is quite possible, however, that a few plants used these classes of scrap independent of my work, for foundrymen were beginning to experiment a little then already. Further, that the establishment of the laboratory in Pittsburgh was known to at least some officers of the National Malleable Castings Co., is indicated by the fact that the late Mr. Pope, president of that company, was a director of the McConway & Torley Co. at the time and for some years thereafter. That he had little use for scientific regulation of the melting, etc.—as indeed was the case universally in the malleable business at that time—appeared in an interview I had with Mr. Pope at his residence in Cleveland some time in 1899. Things have changed since then, and today a malleable man would hate to do without his laboratory.

When I was engaged in the development of the Pennsylvania Malleable Co., of Pittsburgh (McKees Rocks), I had occasion to establish the second chemical laboratory to operate a malleable plant upon proper lines. This laboratory was put in during the summer of 1900, and H. E. Diller, now of the General Electric Co., was called to take charge. It may be of interest to state that the laboratory was purchased as a unit from a western malleable company who had not been satisfied with the returns derived therefrom (but who bought another one some years later just the same).

The above would indicate a considerable interest in malleable laboratories before 1903. Indeed, when the first set of standard specifications for malleable castings was undertaken at my special solicitation by the American Society for Testing Materials, in 1903, the members of the committee were all familiar with the chemistry of the malleable process. The late W. J. Scott, of the J. I. Case Thresher Works among others then had a laboratory in operation many years already. I feel certain that Mr. Schwartz, in making the claim of priority, was entirely unaware of the actual status of the case. I would urge the metallurgists of the malleable castings concerns having had laboratories previous to the preparation of the standard specifications for malleable castings to let this be known, for after 1903 no one can well claim to be a pioneer in the art.

Mr. H. A. Schwartz:—Speaking more particularly to Dr. Moldenke's correction, the statement concerning the first laboratory operated by a malleable company, was based on the writer's best information. Furthermore, this statement was read by a considerable number of people who are well informed as to the early history of the malleable business and was not corrected by them. Nevertheless, the date 1893 set up by Dr. Moldenke, of course, antedates by 10 years the date 1903 on which the Indianapolis works' laboratory was established. This point bears no direct relation to the subject matter of my paper.

There is another question which is, perhaps, worthy of more attention. Dr. Moldenke implies that nobody took any

interest in the chemistry of the malleable process before the time, 1893, when he entered upon this field. He more particularly makes the statement that the late Alfred A. Pope did not think much of the chemical control of the product. Dr. Moldenke should know best what Mr. Pope thought of the success in operation of the McConway-Torley laboratory, since he had first hand, personal knowledge of this matter. Nevertheless, it is but just to the memory of Mr. Pope to correct the statement that Dr. Moldenke makes as to Mr. Pope's lack of interest in laboratory control. I am not old enough either in years or in the business to know when Mr. Pope began to do work on the chemistry of malleable iron. It was certainly before 1880. Mr. Pope, I believe, started in the malleable business about 1868 or 1869, and, having known him very well indeed, I have many recollections of his stories of the early development of the industry under his care. His work must have been begun quite early, for in or about 1883 he lost a valuable series of records, bearing on his experimental researches, through a hotel fire.

Experiments in Annealing Malleable Iron

By H. E. Diller, Erie, Pa.

Years ago I started to anneal malleable iron and followed in the path of others who had annealed malleable iron before me, observing the rules and customs in vogue and acting on the theories which were generally accepted at that time. But as I worked along, getting experience and making a few experiments, I began to think that some of the theories, or possibly they might be called traditions, were not essentially correct, and I have since made further experiments to learn more about the requirements for annealing iron.

In the anneal two actions take place:

First, the carbon changes from the combined state to the free state and remains in the iron as temper carbon. This is the same as graphite in composition, but differs from it in form, as shown by Figs. 1 and 2. This gives us one way of finding out whether a portion, or all of a casting, was gray before it was annealed. Contrast Fig. 1 with Fig. 2. The former was taken from a portion of the casting which evidently was white iron before it was annealed, while Fig. 2 was taken from the same casting and shows from the graphite in the structure that it was gray or mottled before it was annealed.

Second, the carbon changes from the combined state and comes out of the iron.

These two actions take place in varying degrees. In some cases there is no loss of carbon, except in a very thin skin of the casting; while in other cases practically all the carbon is taken out of the casting in the lighter sections.

When only a moderate amount of carbon is removed in the anneal, the fracture of the iron is dark. Such iron is called black heart; while when the greater portion of the carbon is removed, the fracture is steel colored and it is called white heart. The black heart malleable is made in this country

almost entirely, while in Europe the white heart is made to a great extent.

At one foundry in Europe, which was making white heart malleable, I saw a ¾-inch diameter bar pulled, which showed a tensile strength of 72,050 pounds per square inch, and an elongation of 3 per cent in 8 inches. The engineer said that this was about an average test. This is a somewhat higher

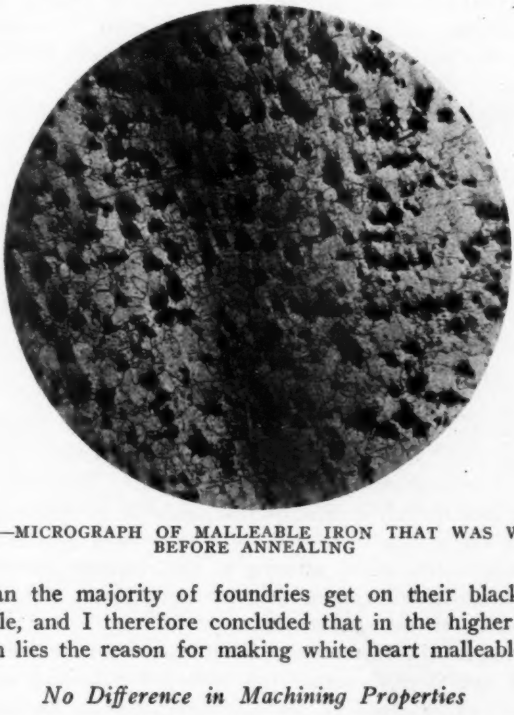


FIG. 1—MICROGRAPH OF MALLEABLE IRON THAT WAS WHITE BEFORE ANNEALING

test than the majority of foundries get on their black heart malleable, and I therefore concluded that in the higher tensile strength lies the reason for making white heart malleable.

No Difference in Machining Properties

One of the claims sometimes made for the black heart malleable is that it is easier to machine than the white heart variety, but in a factory in England which used both kinds, made in different foundries, I was told that there is no difference in the machining properties of the two different kinds of malleable.

I was curious to know how the white heart malleable is made. It had been told me that the carbon came out of the iron in the anneal, due to the higher temperature at which the anneal is conducted, and due to the oxidizing agent used in packing. But the temperatures I saw did not run above 1000 degrees Cent., and I have run anneals at the same temperature without getting a white heart malleable. So I concluded that the temperature could not be the controlling reason for the carbon coming out of the iron. Later, when I learned that the pig iron used in making white heart malleable contains only traces of manganese, I decided that this is probably the governing feature in making the white heart malleable, and that the method of anneal is not the cause. The following are the compositions of two white heart malleable iron castings:

	Silicon	Sulphur	Phos.	Mang.	Combined Carbon	Total Carbon
	Per Cent					
French Foundry...	0.88	0.295	0.057	none	0.80	0.87
German Foundry..	0.71	0.050	0.040	none	0.79	1.02

The casting from the French foundry was made in a cupola, while the other metal was melted in an open-hearth furnace.

The time usually taken for an anneal seems a great deal too long, but I do not believe it can be shortened appreciably without a radical change in present methods. In order to find out just how quickly a piece of iron could be malleableized, and to learn the effects of different packings and gases, I made some experiments while working in the research laboratory of the General Electric Co., at Schenectady, and the following are some details of these experiments.

To start with, a number of test bars were obtained which were all cast from the same iron. Their composition was:

	Per Cent
Silicon	0.710
Sulphur	0.059
Phosphorus	0.168
Manganese	0.270
Combined carbon	2.680
Total carbon	2.680

The first experiments were made in an Arsem vacuum furnace where the sample was away from air and other gases, with the exception of the gases which might be given off by the sample, the carbon resistors, or by the packing, and which would be rarefied. No anneals were made which brought the combined carbon below 0.30 per cent, and the following anneal was found to give as good results as a somewhat longer anneal:

	Hours
Time to temperature	1½
Time at 1000 degrees Cent	6
Time cooling to 600 degrees Cent	3½
Total time for anneal	11

After going through this anneal a bar packed in magnetite had 0.41 per cent combined carbon, and a bar packed in alundum had 0.38 per cent combined carbon. The latter would indicate that an anneal could be made in 11 hours without the presence of any oxidizing agent; in fact the small amount of gas which would be in the furnace would be a reducing gas, due to the heated carbon resistors.

A rectangular bar, 0.53 x 1.02-inch, subjected to the foregoing anneal and given a transverse test 12 inches between supports, sustained a load of 1355 pounds, and gave a deflection of 1.02 inches before breaking, while a bar 0.765-inch in diameter gave a tensile strength of 49,360 pounds per square inch. The amount of elongation was not obtained, as the bar broke at the bench mark.

The next experiments were made in a silica tube, 6 inches inside diameter, heated from the outside by electrical resistance. Experiments were made to find the minimum time for holding at temperature and for cooling to give satisfactory results. The following table is given showing the best results obtained, using different atmospheres and different mediums for packing. In anneals Nos. 84, 85 and 87, carbon dioxide gas was passed through the tube during the anneal, and in anneal No. 73 hydrogen gas was passed through the tube during the anneal. In anneals Nos. 69, 86 and 89 no gas was passed through the furnace and the heated bars were in contact with the air

which did not have free circulation due to plugs of loose asbestos in the ends of the tube.

The figures are as follows:

Anneal No.	No.69	No.73	No.84	No.85	No.86	No.87	No.89
Bar Packed in	Mill Scale	Alundum	Mill Scale	Sand	Powdered Marble	Mill Scale	Magnetite
	hrs.	hrs.	hrs.	hrs.	hrs	hrs.	hrs.
Time to 900 degrees Cent.	8½	8	7½	7½	...	...	...
Time to 850 degrees Cent.	..	...	...	...	6½	5½	5
Time at temperature	22¼	16	16	17	17	16	18
	Deg. Cent.	Deg. Cent.	Deg. Cent.	Deg. Cent.	Deg. Cent.	Deg. Cent.	Deg. Cent.
Highest temperature	968	900	900	900	879	872	900
Ave. temp. during anneal	920	900	900	890	870	870	895
	hrs.	hrs.	hrs.	hrs.	hrs	hrs.	hrs.
Time cooling to 600 degrees Cent.	8½	16	8½	28	16	16	16
Total time	39¼	40	32	52½	39½	37½	39
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Combined carbon	0.08	0.12	0.07	0.15	0.15	0.16	0.30

Cross section of bar, inches, No. 69, 0.52x1.01; No. 73, 0.53x1.02; No. 84, 0.53x1.02; No. 85, 0.54x1.01; No. 86, 0.51x1.00; No. 87, 0.53x1.01; No. 89, 0.53x1.01.

Transverse Test—							
Deflection, inches	1.69	0.73	1.72	1.96	1.38	1.24	1.84
Load, pounds	1150	1025	1200	1315	1125	1160	1310

In anneal No. 73 the sample was packed in a 1-inch pipe with alundum and the ends stopped with asbestos. This was then packed in a 3-inch pipe with coke dust and a stream of hydrogen passed through the furnace during the anneal. While there was considerable temper carbon, and only 0.12 per cent combined carbon in the center of the annealed test piece, at the edge of the test piece there was no temper carbon and 0.92 per cent combined carbon. Fig. 3 is a cross section taken from the edge of the bar, and Fig. 4 is a section taken from the center of the same bar.

From the foregoing tests it appears that if the composition is correct, the only thing essential to annealing or changing the carbon from the combined state to temper carbon is heat. Anneal No. 73 and the vacuum furnace anneals would indicate that an oxidizing atmosphere is not essential, while the other anneals

would indicate that a reducing atmosphere is not essential. Anneals Nos. 73 and 85 would indicate that an oxidizing packing is not essential, while the other anneals would indicate that a neutral packing is not essential.

Effect of Rapid Cooling

In order to show the effect of rapid cooling after the iron has cooled below the recalescence point, four bars ¾-inch in diameter were annealed together, without any packing, and held at an average temperature of 890 degrees Cent. for 17 hours. After cooling to 555 degrees Cent. two of the bars, marked *B*1 and *B*2, were taken from the furnace and quenched in oil, while bars *A*1 and *A*2 were allowed to cool in the furnace. The results of the tests, as given below, would indicate that it is immaterial whether the bars are cooled slowly or rapidly after they have reached 555 degrees Cent., which is still a red heat. The figures follow:

Sample	A1	A2	B1	B2
Elongation, per cent in 2 inches	7.0	7.0	6.5	7.0
Tensile strength, pounds per square inch	44,710	43,020	45,100	45,850
Combined Carbon, per cent	0.15	0.15	0.15	0.15

In all the different tests the only thing which produced a marked shortening of the anneal was a vacuum, and the reason for this I will leave for some one more theoretical than myself to explain.

As a possible practical conclusion from these tests, I would advance the statement that malleable iron could be annealed in a tunnel furnace in 48 hours or less, and that in 72 hours or less after a heat was cast it could be in the shipping room. Let us figure the following schedule:

	Hours
First pots into furnace after heat is poured	6
Time to 900 degrees Cent.	16
Time from 900 degrees Cent. to 1000 degrees Cent. and held there	16
Cooling to 600 degrees Cent.	12
Total time for anneal	44
Final cooling, cleaning and chipping castings in first pots	10
Total time from casting until first castings are ready for shipment	60

There would be a continuous movement of pots through the furnace and in order to take care of two heats a day, the last of the heat would be out 12 hours after the first of the heat, making in all a total of 72 hours from the time the heat is poured until every casting is ready for shipment. These estimates are based on what has been done in the small furnace and allowance made for different conditions

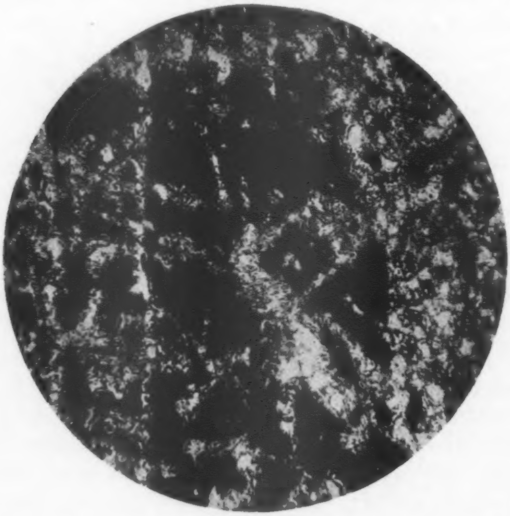


FIG. 2—MICROGRAPH OF MALLEABLE IRON THAT WAS GRAY BEFORE ANNEALING

in the tunnel furnace. Before going farther into this, a brief description of the tunnel furnace might be profitable.

Tunnel furnaces, or kilns, as they are often called, have for some time been used for heating clay ware, and are run at temperatures as high as 1400 degrees Cent. The pots are placed on cars which are pushed into the furnace at the charging end at regular intervals. The cars travel on rails which slope slightly toward the discharge end. These cars are arranged with a sand seal so that the under portion of the car does not become highly heated. The cars, which are put into the furnace at regular intervals, push ahead the cars in front

of them. The stack is near the charging end and the fire boxes are about two-thirds of the way from the charging end to the discharging end. With this arrangement the pots move through the furnace, getting heated on both sides and absorbing heat from the gases as they go to the stack. Thus by the time the gases traveling in the opposite direction to that in which the pots are traveling have reached the stack they have

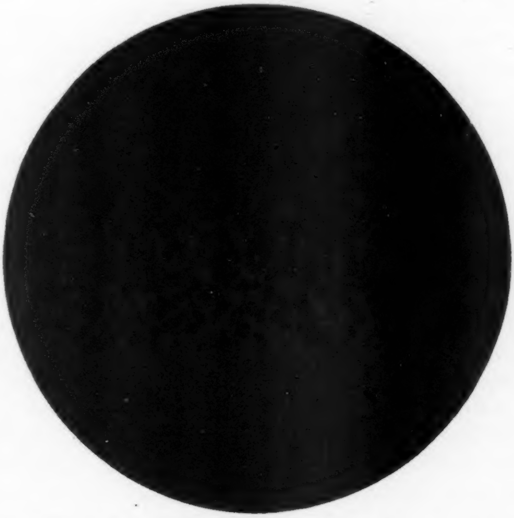


FIG. 3—MICROGRAPH FROM EDGE OF BAR—SAMPLE ANNEALED IN ALUNDUM SURROUNDED BY CARBON

given off most of their heat and are at a temperature of approximately 200 degrees Cent. This gives an idea of the efficiency of the tunnel furnace. The pots thus move along, getting into a hotter zone at each move, until they come to the zone of the fire boxes which could be arranged so that the pots are held at the maximum temperature any desired length of time. After the pots pass the zone of the fire boxes, they travel through part of the tunnel heated only by the heat radiated from the hot pots, and so, as they lose their heat, the pots travel continually into a colder portion of the tunnel, until

they are finally cooled to 600 degrees Cent. or less, when they pass out of the furnace and may be cooled rapidly.

The advantages of such a furnace, judging somewhat from its operation in firing porcelain, would include continuous operation; more rapid output; economy of fuel, brought about by the fact that the greater portion of the heat is extracted from the gases before they pass into the stack and by the fact that

FIG. 4—MICROGRAPH FROM CENTER OF SAME BAR AS SHOWN IN FIG. 3

after the furnace is once brought to temperature it runs continuously and it is not necessary to heat up a cold furnace for every new anneal, as is now the case; lower labor cost of operating; lower cost of maintenance; increased life of the pots, and more regular heating of the castings. Against these advantages would be the one big disadvantage of high first cost.

A Saving in Time

Coming back to the time laid out in the foregoing, 16 hours has been figured for bringing the pot up to 900 degrees Cent. This is approximately twice as long as was required

in the experimental furnace, so that we may conclude that this rate of heating would not be injurious to the iron. It is, on the other hand, half as long as would be required for bringing the temperature to 900 degrees Cent. in a cold furnace charged full of pots in the usual way. We can figure on this reduction of time due to the fact that the pots are entering a hot furnace and that hot gases are continually circulating on all sides of the pots. From the time the first pot reaches 900 degrees Cent. until it reaches 1000 degrees Cent. and passes through the hot zone, 16 hours have been allowed. This is the shortest time for holding the temperature in the experimental anneals, but in those anneals the average temperature was as low as 870 degrees Cent., while in the tunnel furnace the average temperature could be run at 1000 degrees Cent. This high temperature can be held in the tunnel furnace without danger to the metal, because the temperature will be quite even. In the regular annealing furnace a temperature of 1000 degrees Cent. as indicated by pyrometer might endanger the metal because there is very apt to be a variation of temperature in such a furnace of as much as 100 degrees Cent. or more. Running the anneal at 1000 degrees Cent. instead of 900 degrees Cent. would help to shorten the anneal, because the heat would penetrate quicker at 1000 than at 900 degrees, but I have no figures to indicate the exact effect of this increased temperature in shortening the anneal. The time allowed for cooling to 600 degrees Cent. has been increased about 50 per cent over that taken in the experimental anneals.

This schedule is somewhat of a speculation but is based on enough experiments and the actual working of the tunnel furnace in the pottery industry to allow one familiar with the annealing of malleable iron to feel pretty certain that the schedule is close to what would obtain in actual practice. The suggestion is given in the hope that it may be of interest, and introduce a new viewpoint from which to look at the problem of annealing malleable iron castings.

Discussion—Continuous Tunnel Annealing

Mr. Philip d'H. Dressler.—The malleable iron produced in the United States is almost entirely of the type known as black heart. It combines a good tensile strength with greater ductility than usually is found in the white heart malleable produced in Europe. A good average tensile test is about 50,000 pounds per square inch with an elongation of 8 to 10 per cent, and in some cases more.

To obtain the best results, the manufacturer finds that the residual combined carbon should be not more than 0.05 to 0.08 per cent. Furthermore, the temper carbon must be completely graphitized, and a certain amount of decarbonization must take place, dependent upon the use the malleable will be put to. The conditions of annealing required to produce these results are complex. The factors influencing the success of the process may be summarized under the following heads: Temperature; time; packing; and furnace atmosphere.

Time and temperature are mutually dependent and may be conveniently considered simultaneously. As usual in physical and chemical changes, the higher the temperature, the quicker is the conversion of carbon from the combined to the free state. In fact, the speed of the change is found to be proportionate, roughly, to the temperature above 1300 degrees Fahr. There is, however, a double limitation upon the temperature that can be carried, imposed first by the fact that overheated malleable develops a coarse structure and suffers a loss of ductility, and second, by the excessive depreciation of the iron pots at high temperatures.

After the completion of the change of the carbon from the combined state, the cooling must be sufficiently slow so that

all the carbon may separate as graphite. It is found that this process occurs at temperatures down to 1300 degrees. Quenching at lower temperatures, Mr. Diller states, has no bad effects.

Experiments show, also according to Mr. Diller, that the nature of the packing has no very marked effect upon the rate of conversion of the carbon, although a packing of mill scale, by promoting the decarbonization, reduces the active mass

FIG. 1—ENTRANCE END OF DRESSLER TUNNEL FURNACE, SHOWING HYDRAULIC PROPELLING GEAR

of the temper carbon, and probably permits the conversion from combined to temper carbon to proceed a little more rapidly and completely.

Decarbonization is, however, naturally very dependent upon the packing. Mills scale promotes it and neutral packing does not. Temperature has also a marked influence, the rate of decarbonization being much more rapid at high than at low temperature.

The atmosphere of the furnace has a bearing upon the decarbonization. Under slightly oxidizing conditions, the packing around the castings is kept active. It is probable also that there is some direct oxidation of the carbon by the atmosphere.

This is particularly seen where the annealing is carried out in mufflers, without packing, when the carbon content is reduced by the oxidizing action of infiltrating air and gases. If the atmosphere is more than slightly oxidizing, the pots suffer from excessive scaling.

The Dressler continuous annealing furnace is producer gas fired, of the tunnel and car type. The material to be annealed

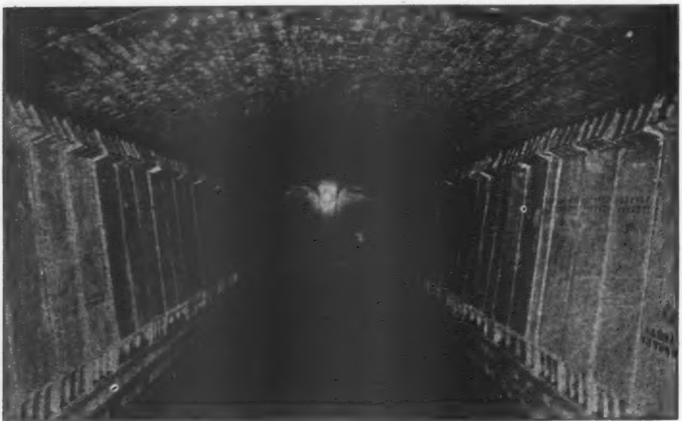


FIG. 2—VIEW INSIDE HEATING ZONE OF KILN, LOOKING TOWARD THE ENTRANCE END, SHOWING COMBUSTION CHAMBER

is loaded on a train of cars progressively pushed through the furnace by means of a mechanical device, as shown in Fig. 1. The kiln is divided into three regions: The heating zone in which the material is brought to the desired temperature; the soaking zone in which it is maintained at that temperature; and the cooling zone.

The furnace differs from others of the continuous type in that it is a complete muffle; neither the air for combustion nor the products of combustion are brought into contact with the work. On either side of the kiln in the heating and soaking zones are lateral combustion chambers, as shown in Fig. 2. These combustion chambers form continuous tubes throughout this distance. The gas and air are introduced into them at

intervals in the soaking zone. Combustion takes place within them, and the products of combustion are drawn off through them by means of a fan, toward the entrance of the kiln, in an opposite direction to the progress of the cars.

The kiln resembles other types of muffle kilns in that the flame is screened from the pots, but differs in the important feature that there is no structural connection whatever between the chambers and the kiln proper. They simply rest on a bed of sand and are free to expand and contract independently of the kiln, thus avoiding the strains which rapidly destroy some muffle kilns. The combustion chambers may thus be described as floating.

How Combustion Chambers Operate

The combustion chambers are made in sections dovetailing into each other and luted with fireclay. Each section is composed of four refractory pieces, somewhat resembling thin-walled, hollow tile, as shown in Fig. 3. The space between the inner and outer walls is continuous around the combustion chambers. The mechanism by which the heat is transferred from the flame to the pots is as follows:

The inner wall of the combustion chamber is directly heated by the flame. The vertical portions of the chambers thus act as hot flues and draw the atmosphere of the kiln through the openings at the bottom and discharge it at the top. On emerging, this is somewhat hotter than the pots on the cars; it is cooled by them and falls through the passages provided to the level of the bottom of the chamber, around which it is once more drawn. A constant and vigorous circulation of the kiln atmosphere is thus maintained, and the heat in this way is evenly distributed throughout the mass of the pots.

The outer wall of the combustion chamber facing the pots acts as a screen, cutting off the direct radiation from the hot inner wall, thus permitting a very hot and efficient combustion to be maintained without local overheating. The circulation is clearly shown by the arrows in Fig. 4.

In the cooling zone, the heat is abstracted from the pots by means of a series of cast iron pipes occupying the same relative position on either side of the kiln as the combustion chambers

do in the heating and soaking zones. This is shown in Fig. 5. Through these pipes, air is drawn from outside of the kiln. During its passage, it cools the pots, and is itself heated to about 700 degrees Fahr., at which temperature it is delivered to the combustion points, thus giving the kiln the benefit of the

FIG. 3—SINGLE SECTION OF COMBUSTION CHAMBER—THE ARROWS INDICATE THE DIRECTION OF CIRCULATION

principle of recuperation. In the case of kilns for annealing malleable iron, between the end of these iron pipes and the beginning of the combustion chambers, a space is left in which the pots are allowed to cool slowly down to 1300 degrees Fahr.

Double Doors Form Air Lock

At either end of the kiln are double doors forming air locks so that cars can be put into the kiln and withdrawn without allowing air to enter from outside. If it is desired to carry a

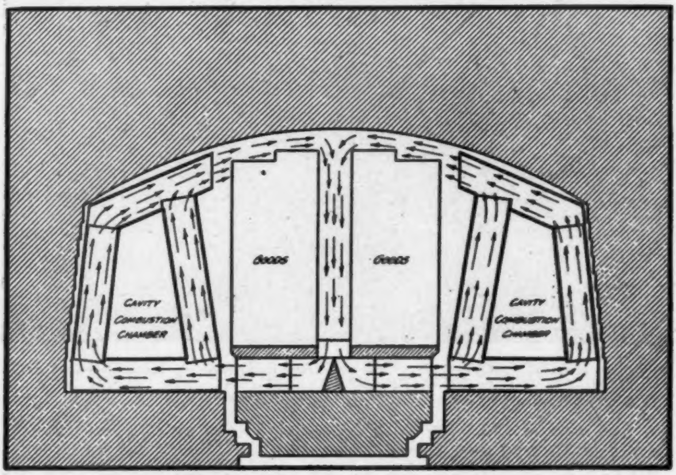


FIG. 4—DIAGRAMMATIC SKETCH SHOWING MECHANISM OF HEAT DISTRIBUTION IN HEATING ZONE

reducing atmosphere in the kiln, after closing the outer doors the air in the locks between the doors can be swept out with gas or the products of combustion before the inner doors are opened.

The economies effected by this type of furnace can be grouped under the following heads: Fuel; pots; labor; time; and improved quality of product.

The principle of continuous firing, involving a cool exhaust and the recuperation of the heat of the cooling pots by means of the air of combustion leads to great economies. Further-

more, it is possible to carry a very much hotter and more efficient combustion in the chambers without overheating the castings than is possible where the flames come directly in contact with them.

The usual fuel consumption in annealing malleable iron in intermittent furnaces is from 800 to 1000 pounds per ton. Figuring that the total weight of the malleables, packing and

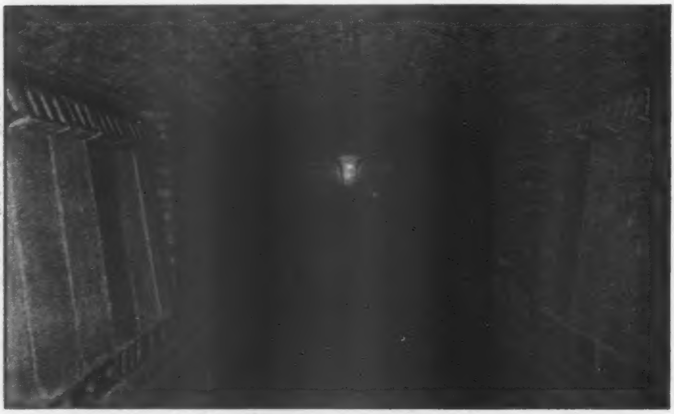


FIG. 5—INSIDE VIEW OF ANNEALING FURNACE, LOOKING FROM SOAKING ZONE TOWARD EXIT END—THE AIR PIPES FOR COOLING CAN BE SEEN ON EITHER SIDE OF CAR

boxes is three times that of the castings alone, this represents 260 to 330 pounds per ton of the total weight heated. In the Dressler kiln, the fuel consumption is from 90 to 100 pounds per ton of total weight.

The chief destruction of pots in the direct-fired kilns is due to the direct action of the flame upon those nearest the fire boxes. In order to attain the minimum temperature of annealing in the coolest portions of the kiln, the hottest portions are heated to nearly 1800 degrees Fahr., at which temperature the iron scales very severely, particularly if the flame is oxidizing. In the Dressler kiln, the atmosphere can be regulated, as described, to be reducing or only slightly oxidizing conditions. Moreover, the flame not coming into contact at all with the pots, the periods of excessive heat, when

the fires are fed are avoided. The result is a lengthening in the life of the equipment, even though a higher general temperature is carried than in the direct-fired furnaces.

Labor Cost Reduced

The loading and unloading of the cars is all performed outside the kiln under the best conditions. It is invariably found that a considerable labor saving results.

The usual annealing furnace is of the down-draft type with the fireboxes on one side. In such a furnace, the pots next to the fireboxes are always from 200 to 250 degrees hotter than those near the floor on the opposite side of the kiln. The time of annealing of the furnace full of malleables is really determined by those in the coolest part. If a higher temperature could be carried without overheating the pots nearest the fireboxes, a saving of time would be effected.

In the Dressler kiln, owing to the distribution of heat, there is no lag of one portion behind the other so that the highest practicable temperature can be carried over the whole mass—that is to say, supposing 1800 degrees to be the highest temperature at which annealing can be carried out, the period that the castings would have to stay in the heat would be that necessary to anneal malleable at 1800 degrees, and not that necessary to anneal them at 1550 degrees, as in down-draft kilns. Furthermore, in the case of the intermittent furnace, the whole mass has to be started from cold, whereas in the tunnel furnace small masses at a time are introduced into an already hot kiln, thus cutting down the time required to heat up to the annealing temperature. In cases where the castings do not tend to warp, they can be placed in trays without packing, and the atmosphere of the kiln kept sufficiently oxidizing to bring about the necessary decarbonization, exactly as in the present intermittent muffle process. The cutting out of the packing lessens the lag between the inside and the outside of the pot or tray, and enables the annealing to be carried through more quickly.

Owing to the even distribution of heat through the pots, and the fact that every car has to go through the same treatment as every other car, the writer believes a much more

uniform product is obtained by use of the Dressler kiln than is possible with any other kiln. When the correct conditions for annealing have once been established, there is no difficulty in maintaining them. The temperature throughout the kiln is controlled by thermocouples placed in the vault. A slight adjustment of the gas dampers will correct any tendency to vary. It is always very much easier to maintain a constant temperature in a continuous furnace than to raise the temperature of an intermittent kiln in accordance with a set schedule.

MR. O. W. STOREY.—This paper goes over a portion of some work that I had occasion to do five or six years ago, the results of which I presented before this association in 1914. Mr. Leasman, who did some work under me during 1913, presented his results in 1913. Mr. Leasman spoke of the effects of packing materials on malleabilizing. He showed in that paper that the packing material had very little to do with the structure of the interior of malleable iron. The packing material had some influence on the skin structure, however. A great many packing materials were used—I think somewhere in the neighborhood of 50 to 75—in his experiments. I continued this work and became interested in the theory of malleabilizing and wished to clear up a few points which had been brought up. Unfortunately I was never able to complete the research work I started at that time.

I tried the effect of different temperatures and of various rates of cooling. At the present time I do not recall some of the figures in my paper, but I found the malleabilizing could be carried on at temperatures in the neighborhood of 1600 degrees Fahr. I got some results which I could not explain at first until I looked into the rate of cooling of malleable iron after being annealed. I found that if the malleable iron was cooled too rapidly from 1600 to 1700 degrees, a steely structure resulted. Such malleable iron is hard even with long annealing.

Investigating this further, I found that this steely structure was due to the malleable iron cooling too rapidly to about the recalescence point. The rate of cooling below that did not seem to have any influence on the structure. I did not

have at that time the time to determine the rate of cooling as affecting the structure, that is, I did not have time to get the curves which would result with the different rates of cooling, but I found that a certain minimum time was necessary to secure the complete breakdown of the iron carbide in the malleable iron. If this cooling was too rapid, the structure consisted of pearlite, ferrite and temper carbon. If the cooling was slow enough, all of the pearlite broke down into temper carbon.

After doing this I carried on some experiments on the reheating of malleable iron. I took some perfectly malleablized iron, consisting entirely of ferrite and temper carbon, and reheated it. By reheating some of this material to about 1400 degrees Fahr., some of the temper carbon went into solution again, and on cooling this iron rapidly I got a structure consisting of pearlite and temper carbon. About 1400 degrees seemed to be the lower limit at which the temper carbon went into solution again. At 1600 to 1700 degrees this temper carbon went into solution rapidly. It took only two or three minutes at that temperature to have the structure consist entirely of a pearlite and temper carbon. Not all of the temper went into solution, but portions which were comparable to the temperature used.

This would seem to tell us, in cooling down the original malleable iron, why the iron carbide does not break down entirely if the cooling is too rapid. As you lower the temperature there is a certain time action necessary to complete the entire breakdown of the iron carbide.

As far as malleable structure is concerned, the time of cooling is an important factor and it must be taken into consideration to produce a structure which is not hard and steely.

THE CHAIRMAN, MR. W. R. BEAN.—For the benefit of those who have just heard the remarks, I would say that the speaker was Mr. Storey, of the Burgess Laboratories.

I might say in connection with the tunnel kilns annealing process that about a year ago I took up the question briefly to see what might be accomplished, my attention having been brought to the Dressler type of annealing kiln.

Several months ago I visited one of the Steel corporation's sheet plants where such an oven is in operation and has been for some months, annealing tin plate. Recently I sent tensile bars and wedges to be put through the regular tin plate annealing process by simply placing them on top of the pots containing the tin plate. That was a 48-hour process. The maximum temperature reached was approximately 1600 degrees. Neither the tensile bars nor the wedges were thoroughly annealed in that time. The tensile bars showed a strength varying between 60,000 and 72,000 pounds per square inch; the highest elongation was 3½ per cent in 2 inches. The fracture was practically white, although not the white of the white iron. The fracture of the wedges in the thin section was gray, not black, and there was a considerable amount of combined carbon present. The combined carbon that was present was not the result of the rate of cooling, but was the result of insufficient time at a temperature necessary to convert the carbon to the graphitic temper form.

The proposition has interested us, particularly from the standpoint of the possibilities of reducing fuel consumption, and where castings are annealed, as in many cases in large castings, without packing, the process seems to me to afford opportunities of improving materially the annealing from the standpoint of cost and also somewhat possibly from the standpoint of time. Temperature control seems to be good.

Mr. D. W. Storey.—I have occasion to know that in one plant they are annealing malleable castings without any packing material at all. They simply have a muffle furnace and heat the castings and cool them in that furnace. In my experiments I annealed some test bars in brass. I melted the brass around the test bars and annealed them in that way, and I got a good malleable structure. Temper carbon was present throughout the entire structure up to the edge where the brass had alloyed with the iron, showing that you can get this structure irrespective of the packing material.

Advantages of Malleable Iron Versus Steel for Agricultural Castings

By P. A. Paulson, Rockford, Ill.

The purpose of this paper is to explain, in a measure, the reason for the continued increase in the uses of malleable iron and particularly to show its adaptability to the manufacture of agricultural implements. It would not, therefore, be amiss to give briefly some facts regarding the metal itself. The last few years have seen wonderful progress in the production of malleable iron. This fact has not become sufficiently and generally known.

A few designers and engineers, not yet sufficiently versed in its present high quality, regard malleable iron as a doubtful quantity, due probably to the failure of some manufacturers in the past to safeguard their product, and to the hesitancy of the producers, generally, to speak its excellent properties loudly enough.

Reliable manufacturers are now continually, and for several years past have been producing a metal averaging over 50,000 pounds ultimate strength to the square inch, sometimes even exceeding 60,000 pounds ultimate. To obtain an elongation of 20 per cent in 2 inches has been a regular occurrence, and a 30 per cent elongation has been obtained in some instances. The ultimate goal we are striving for at present is to reach an average of 60,000 pounds ultimate with a 30 per cent elongation. These statements might be looked upon with doubt, and it might be said that these were exceptional instances, thus casting doubt as to the uniformity of the metal from different heats. We wish to present some data to dispel this idea, and we wish it understood that these data do not represent the results of one concern alone, but of many. The following figures give the tensile strength of bars of ⅝-inch

diameter and the elongation in 2 inches. They are from seven consecutive heats, and the tests were made in the laboratory of Prof. Enrique Touceda at Albany, N. Y. The figures follow:

Ultimate strength Pounds per square inch	Elongation per cent
53,680	18.50
58,223	19.00
54,978	15.50
54,478	22.00
56,860	23.50
56,512	24.00
54,612	16.50

These figures show an average ultimate strength of 55,620 pounds and an average elongation of 19.85 per cent.

Ratio of Elastic Limit to Tensile Strength

It might be of interest to know how the elastic limit compares with the ultimate strength. The following data are submitted, the first column containing the elastic limit in pounds per square inch, the second the ultimate strength in pounds per square inch:

Elastic limit Pounds per square inch	Ultimate strength Pounds per square inch
30,642	51,310
28,075	50,540
31,994	50,540
27,925	51,560
28,525	52,340
31,887	55,540
31,110	54,640
30,570	54,268
28,610	55,982

The average elastic limit will be found to be a little better than 56 per cent of the average ultimate strength, the best being a little better than 63 per cent.

Thus we have endeavored to point out briefly some of the outstanding features of the metal itself, and these properties have been strikingly shown when in numerous instances castings have withstood without fracture distortion into every conceivable shape.

Agricultural Implement Castings

Considering castings for agricultural implements, it may be said they are for the most part light in weight and section. It is to the interest of the manufacturer of imple-

ments to make his machines as light as is compatible with service. The malleable iron founder is the one who can be of the greatest aid in attaining this end. Thin sections can be poured with the white iron which cannot be poured successfully with steel. The steel founder would require these sections to be made heavier before attempting to pour them, and thus, the lightness of the finished machine would have to be sacrificed.

To show further the adaptability of the metal, tests have been made on sections of metal up to 5 inches square and 12 inches long, showing a fine, close grained iron, perfectly annealed in the regulation annealing period, at approximately 1500 degrees Fahr. in six to seven days.

Soundness of castings is an important consideration, and in this item, I believe malleable is superior to steel. The steel bath must be heated to a much higher temperature than that to which the white iron bath is heated. Castings poured with metal at a high temperature are very prone to have blow holes, and hence, the finished product of the malleable founder would be more reliable as far as soundness is concerned. With regard to the selling price as compared with steel, the difference is naturally quite considerably in favor of malleable, owing to the lessened cost of production.

It will thus be seen that castings made of malleable iron are able to give satisfaction. To prove this it has been shown that the metal itself has superior qualities which are more than equal to the demands of the service required from agricultural implements. The cost and reliability of malleable are such as would warrant even a more general use. To these considerations, we may add the distinctive property which malleable has, namely, its resistance to the process of rusting. It has been found that installations of malleable iron castings have outlasted several installations of the same castings made of steel. Thus is added length of service, a very important consideration for any machine or part thereof.

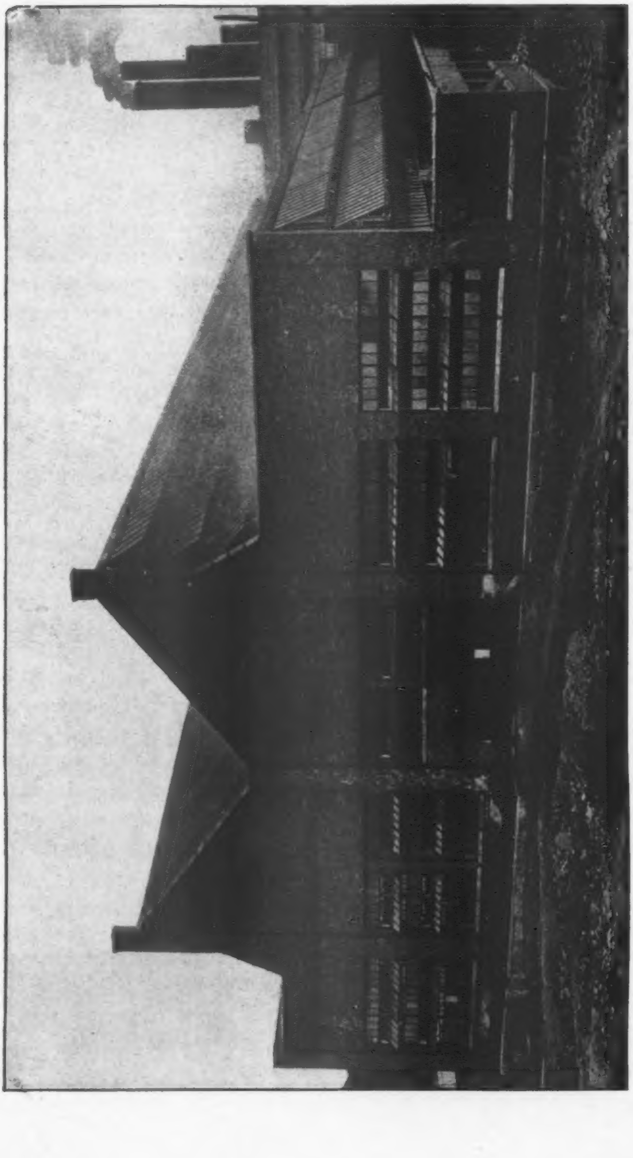


FIG. 1—OUTSIDE VIEW OF COREROOM BUILDING

A Modern Coreroom

By DONALD S. BARROWS, Rochester, N. Y.

The T. H. Symington Co. has recently placed a new coreroom building in operation at its malleable iron plant at Rochester, N. Y., of which Figs. 1, 2, 3 and 4 show respectively an outside view, first floor plan, basement plan and cross section. The installation was designed to balance a melting capacity of approximately 50,000 tons per year and comprises three batteries of eight ovens each. Each oven section accommodates

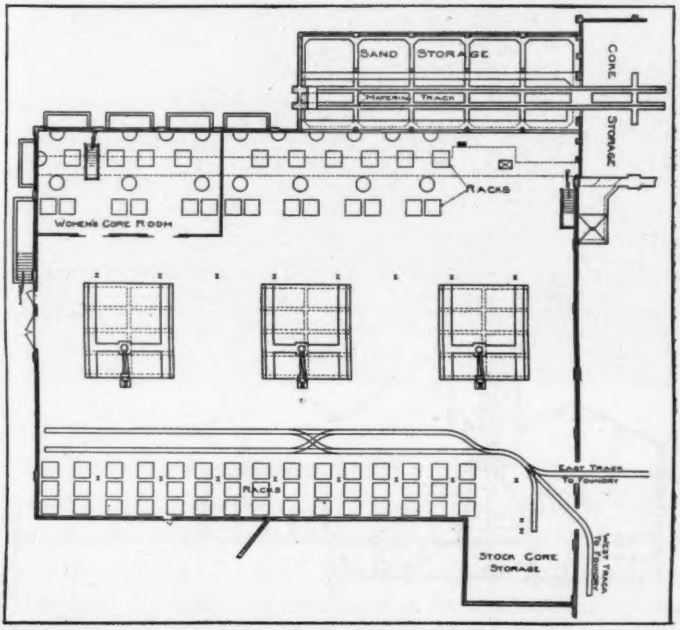


FIG. 2—FIRST FLOOR PLAN OF COREROOM

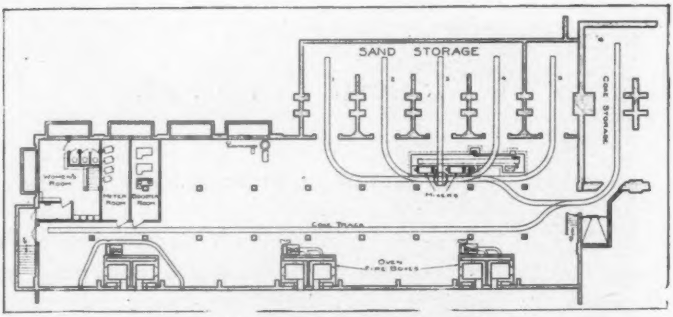


FIG. 3—BASEMENT PLAN OF COREROOM

two core racks 5 feet square and seven shelves high. Each battery of ovens is provided with a firebox in the basement thus avoiding the handling of fuel and ashes in the coreroom proper.

From Fig. 4 it will be noted that sand and coke are delivered on the elevated standard gage track over the material bins at the left. Fig. 3 shows the arrangement of narrow gage track in the basement in connection with each storage bin. The oven fireboxes are designed primarily for the use of coke and this is supplied from bin No. 6 by means of small steel charging cars which are also used for the removal of ashes. Sand is shoveled from the storage bins into small end dump cars, Figs.

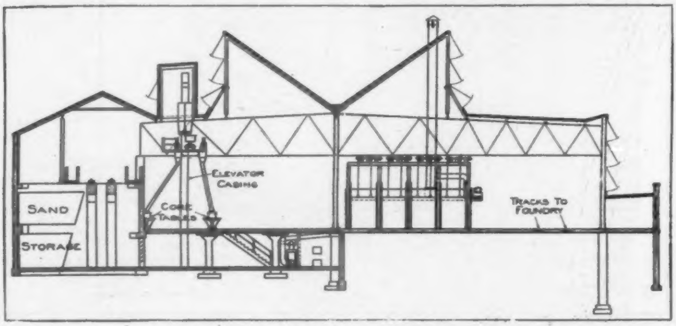


FIG. 4—CROSS SECTION OF COREROOM

5 and 6, each holding exactly one mixer batch. These cars empty into mixers placed below the basement floor level, the latter being arranged to dump by power on a belt conveyor from which in turn the mixed sand is emptied into the boot of a

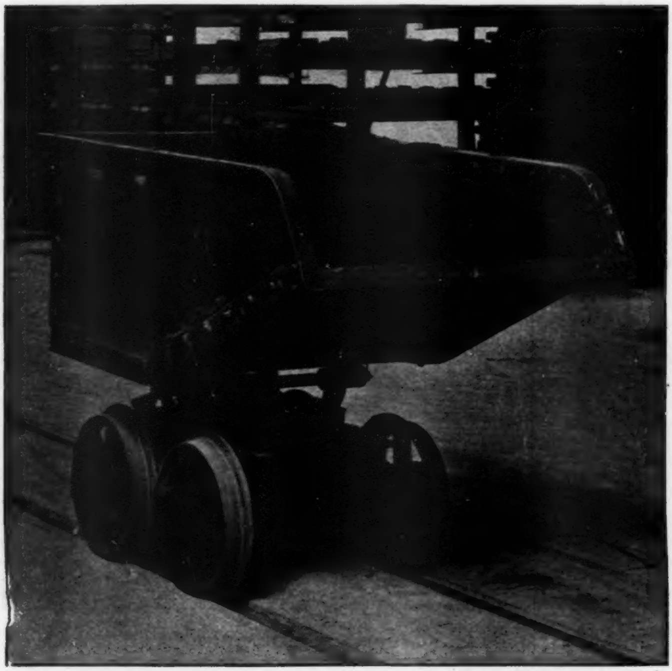


FIG. 5—DUMP CAR FOR HANDLING CORE SAND

vertical bucket elevator. This elevator extends through the main floor of the coreroom and discharges into overhead hoppers approximately 29 feet above the floor level. This arrangement is shown in Fig. 7. From these hoppers the sand is emptied into steel cars similar to those used at the mixers, running on a suspended platform over the coremakers' benches. Each of the

latter is provided with a suitable spout and hopper to receive the sand.

How Cores Are Handled

Empty core racks are placed conveniently to the coremakers' benches as shown in Fig. 2 and these racks when filled are picked up and transported by an electric elevating truck to the

FIG. 6—ANOTHER VIEW OF DUMP CAR

ovens. After the cores are baked, the racks are removed from the ovens and placed along the other side of the building; the cores are then placed either on shelves under the leanto or directly on four-wheeled core cars on a track system leading to the foundry. While a certain job is running, the core plates are left on the racks and the latter returned to a bench working on the same kind of core. The tracks leading to the foundry are shown in Fig. 2, one extending the full length of the molding floors on the west and the other on the east so that cores can

be delivered with the shortest possible carry. The main object sought in this layout was the continual movement of material across the building through the successive stages in the core-making process. The coreroom has been in operation a sufficient length of time to justify the arrangement of its equipment.

In designing the building itself the principal object was the not unusual one of obtaining the most economical construction possible consistent with a permanent and serviceable structure, securing at the same time effective ventilation and lighting both by day and at night. The entire interior including the steel

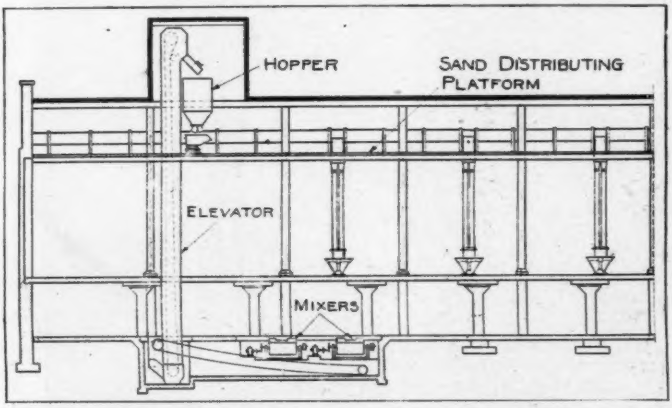


FIG. 7—ARRANGEMENT OF SAND HANDLING APPARATUS

work, is painted white and the absence of shadows and uniformity of lighting is shown by Fig. 8. The use of the Pond truss with continuous monitor sash and with continuous sash for intakes along the east and west walls, has provided a system of ventilation which can be adjusted accurately to meet the existing weather conditions. Provision has been made for hoods over the oven doors with stacks leading through the monitor roof but experience with the building has shown them to be unnecessary.

To comply with the New York State laws it was necessary that that portion of the coreroom occupied by women operators should be in a separate enclosure from the ovens and this portion was therefore enclosed by hollow tile walls and a light reinforced

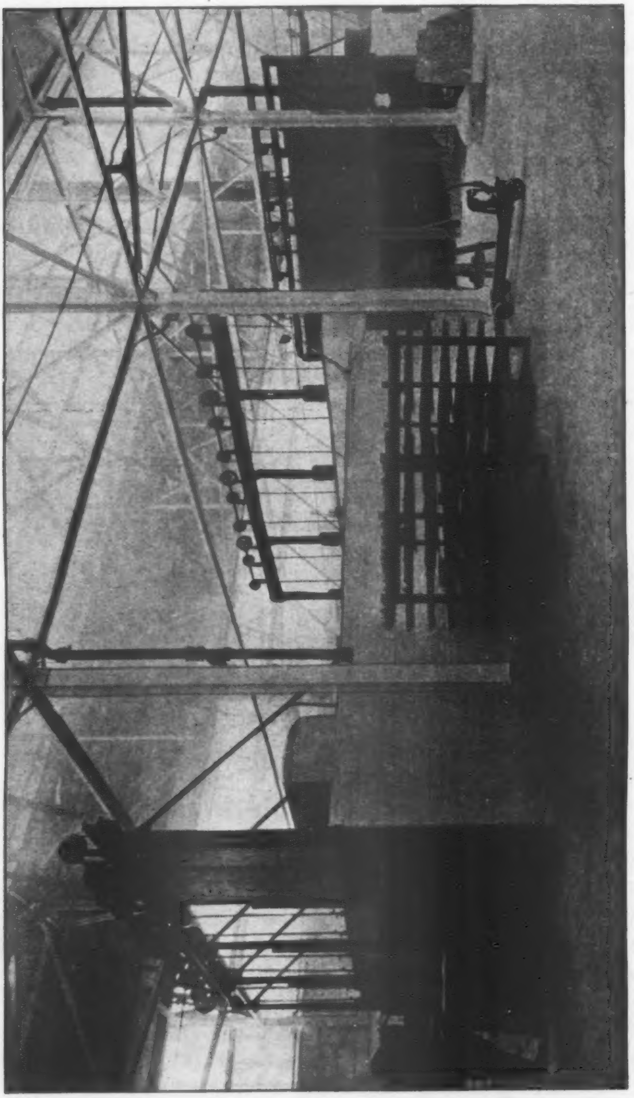


FIG. 8—INTERIOR OF COREROOM SHOWING ABSENCE OF SHADOWS AND UNIFORMITY OF LIGHTING

concrete ceiling suspended from the trusses. A stairway leads from the women's coreroom to a rest room in the basement, connecting with a separate entrance at the foot of the outside stairs.

Type of Roof

The amount of steelwork in the building was reduced to the minimum by maintaining purlin and rafter spacing of about 10 feet, the roof slab being reinforced gypsum 4 inches thick poured

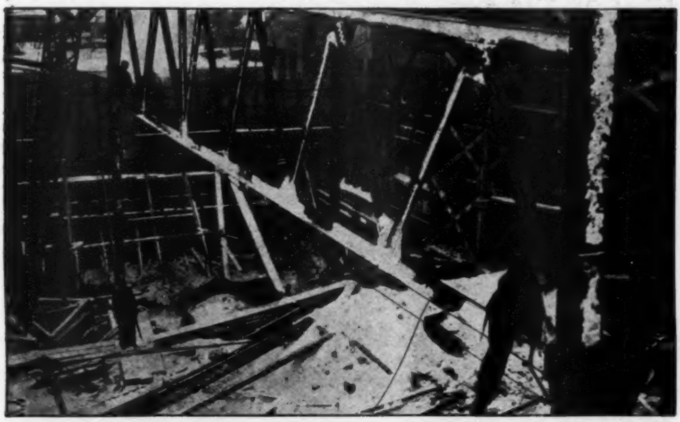


FIG. 9—ERECTING STRUCTURAL STEEL WORK IN MIDWINTER

in position. This type of roof was adopted because of its high insulating value and light weight. Theoretically a gypsum roof can be poured regardless of temperature as the material sets in about 20 minutes. This particular roof was applied in December and January of last winter and the difficulties encountered from the composition freezing to the forms and the inability to secure a smooth upper surface have satisfied us that a monolithic roof is not a winter proposition. The character of the upper surface made the waterproofing doubly difficult and required a considerable extra amount of pitch to fill in the depressions so that the felt could be applied.

The interior building columns and monitor struts are of H-beam section and the purlins are 12-inch channels for the

flat roof and 12-inch I-beams for the main monitor. The Warren type of roof truss was adopted partly for the reason that it provides a clear opening at the suspended sand transfer platform and requires also a minimum amount of reinforcement for local bending moments at this point. The steel contractor

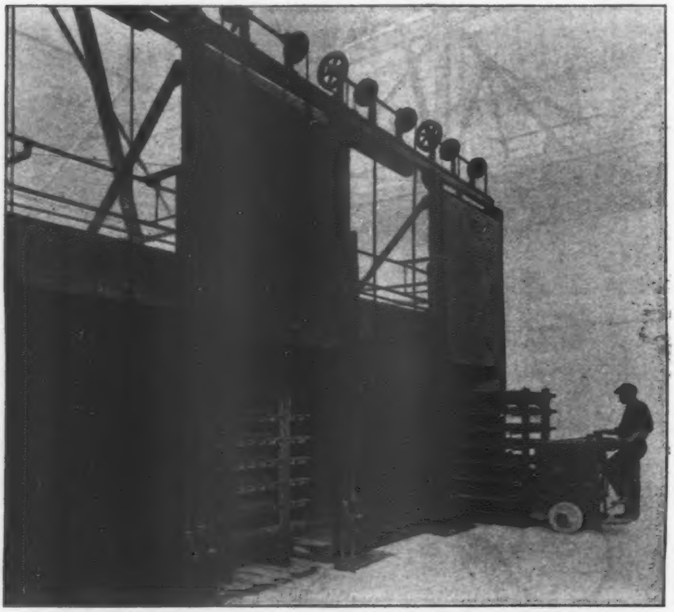


FIG. 10—ONE OF THE OVEN BATTERIES WITH ELECTRIC TRUCK HANDLING A LOADED CORE RACK

was hampered considerably in the erection of his material by the severe winter and Fig. 9 gives some idea of the conditions under which this part of the work was prosecuted.

The floor from the line of center columns to the west wall of the building is of concrete of 6-inch thickness laid on well-tamped earth fill while from the center columns to the east building wall the floor is an 8-inch reinforced slab with intermediate reinforced concrete columns.

The sand bins are of reinforced concrete up to the track level, including the track girders and piers. The sand bin track is a continuation of the existing material track in the adjoining foundry building, and this fact determined its location. The bins are designed to hold a three months' supply of core sand to carry through the worst part of the winter.

The rack type of oven is no longer an experiment but for the sake of completeness there is shown in Fig. 10 one of the battery fronts with the electric truck handling a loaded rack. These ovens were designed and installed by the H. M. Lane Co., Detroit, which also furnished the detail designs of reinforced concrete work and co-operated with the Symington company in the general design of the building. The masonry and steel contracts were handled respectively by A. Friederich & Sons Co. and the Genesee Bridge Co., both of Rochester, and the gypsum roof was applied by the Aspromet Co., of Pittsburgh. The mixed sand conveyor and elevator was furnished by the Stephens-Adamson Mfg. Co., Pittsburgh, and the mixers are Blystone with power dumping mechanism. The electric elevating truck is one of the standard sizes manufactured by the Automatic Transportation Co., Buffalo. For the grating over the mixer and conveyor pit the Irving grating was used and we have found that it is slip-proof regardless of the amount of oily sand which may adhere to it.

It was mentioned previously that the oven fireboxes are designed primarily for the use of coke. The ovens are also designed so that gas burners may later be applied and one battery of eight ovens is now being operated with artificial gas using thermostatic control. These ovens have not been operating long enough for us to come to a definite conclusion as to the relative economy of the two types of fuel but it is expected that this will be determined shortly. It is our intention later to equip one battery with oil burners so that a threefold comparison may be made. The provision for possible use of any one of three fuels would seem to insure continued operation of the coreroom regardless of conditions which may arise in the fuel market.

The Integrity of the Casting

By Enrique Touceda, Albany, N. Y.

The writer can think of no subject of more vital interest to the manufacturer of malleable iron castings, or one to which for his own welfare he should pay more strict heed, than is implied in the title to this paper.

While many of the problems in connection with the metallurgy of the process have now been solved, and we know with certainty the conditions that should obtain in order to regularly produce such a character of hard iron that when annealed it will yield metal of superior strength and ductility, as well as all details of heat treatment that will uniformly produce best results, failure on the part of some to make sure at all times that castings are invariably sound throughout, remains the one deep-seated canker which if not cured bids fair to eat into the vitals of the industry.

It is not to be inferred that the malleable iron casting is unique in this particular, because the statement just made can be applied with even greater force to both steel and to non-ferrous castings generally, especially in regard to blow holes of significant size and to internal strains, from both of which difficulties the malleable casting is exceptionally free. When unsoundness does exist, it usually arises and has to do mainly with that character of porosity resulting from disproportionate sections in the casting which manifests itself as a rule, never in blow holes, as such arise from other causes, nor in voids of any size; but in a more or less fine sponginess which weakens the section at its location.

Value of Tests is Great

There is great and unquestionable value derived from the physical tests of each air furnace heat, for it is through such tests alone that the manufacturer can be assured, as well as prove to the purchaser's inspector, that up to and through the

annealing process he has produced exactly what was sought; but this is as far as it goes, for the latter is not buying test bars, nor are these being used commercially. In what has preceded it has been implied that the majority of the producers of these castings are in a position to positively guarantee both the quality and uniformity of their product when measured by physical tests on test-bars from each heat. That this is true the writer can state unqualifiedly, while in the case of a more or less limited number, a similar statement in regard to the integrity of their castings can be made with equal force and assurance; but that he is forced to make this particular qualification is exactly what has occasioned the choice of this topic by the writer. It is more satisfactory always to be specific and to furnish data where such is possible. With this object in view I subjoin figures showing the combined monthly average ultimate strength and elongation of some 32 different concerns covering May, June and July, the data being gathered from many hundreds of tests made during each month.

May

Average ultimate strength, lbs. per square inch....50171
Average elongation, per cent 10.78

June

Average ultimate strength, lbs. per square inch....50235
Average elongation, per cent 11.14

July

Average ultimate strength, lbs. per square inch....50715
Average elongation, per cent 11.59

The above data should furnish justification for what has been stated as to the ability of many makers to produce with constancy a metal of superior strength and ductility, even under the handicap of inability, due to present stress, to make use of as good a quality of pig iron and fuel as are necessary for best production. Also, in looking over these records it is only fair to consider, that included in them are bars from concerns in which high strength and ductility have been sacrificed, in order to secure such a character of metal as would machine with the greatest ease, this property in these particular cases being the predominating requirement.

In order to illustrate what is possible of accomplishment there is recorded herewith a run of 24 successive heats, the bars having been received in three batches, the first consisting of 12, the second of six and third of six.

First. Lot of Twelve

Average ultimate strength, lbs....................58493
Average elongation, per cent 22.91

In this lot one bar had an elongation of 29.00 per cent and another of 27.00 per cent.

Second. Lot of Six

Average ultimate strength, lbs....................58033
Average elongation, per cent 18.12

One bar in this set had only an elongation of 9.50 per cent, this lowering the average considerably.

Third. Lot of Six

Average ultimate strength, lbs....................57371
Average elongation, per cent 23.83

One bar in this set stood 30 per cent elongation.

The average ultimate strength of the 24 bars is 57,969 pounds per square inch, and the average elongation of the 24 bars is 21.62 per cent. If the manufacturer has been able to arrive at such a point of excellence, at a point where he can positively guarantee that the test bars from each and every heat will meet very rigid and exacting requirements, it is pertinent to inquire why in the case of many have they been so dilatory in connection with proper molding methods.

The writer is going to make an attempt to answer this inquiry correctly and to place the blame where it belongs. It is safe to assume that in the very early days of the industry, the malleable iron casting that was solid throughout was the exception. Lack of solidity, as already inferred, was not due to the presence of blow holes, but was the result of failure on the part of the founder to recognize the fact that in castings of disproportionate sections, and by far most malleable iron castings are of this character, the thinner sections, solidifying more quickly than the heavier ones to which they are attached, would draw the metal from these still fluid parts, before they in turn were able to secure their full quota of metal from the risers.

This state of affairs I presume was productive of so many failures that efforts were concentrated to better these condi-

tions, first, presumably by varying the position and size of gates and risers, etc., but finally by some bright mind determining that the cause of the trouble was fundamentally due to the difference in the rate of cooling of thin and thick parts. Once this conclusion had been reached, it is easy to see that the use of the chills to equalize cooling was the natural and obvious outcome.

It was then perhaps found that while under the arrangement of gates and risers used the chill could not equalize the cooling sufficiently in the majority of cases to make heavy parts perfectly sound, it did serve both to lessen the unsoundness, or shrink as it is called, and to drive it from a place where its existence meant scrap, to a locality much less harmful.

Chills Are a Curse

While not positive, I feel quite sure that the use of the chill originated with the malleable iron founder. Be this as it may, its use in the early days, while an important step in advance, has since operated to deter progress along the lines of soundness to a greater extent than has any other agency, for the reason that the founder has remained content to adhere to this as a palliative rather than seek after the real cure. There has been a continual effort on his part to shift the boil on the end of his nose to some place on his body where it will be both hidden from sight and less painfully located, instead of taking proper and effective steps to eradicate the cause.

Aside from cases of intricate and improper design in which it is practically impossible to properly feed the casting, the chill has been baneful in its influence and a curse. As already stated there are now a large number of founders who are able to guarantee that the physical properties of their castings will square with that of the test bar. Such, for the most part, have discontinued the use of the chill, and are so feeding their castings by means of large reservoirs of metal that soundness results and shrink is absent. These concerns have made a thorough study of molding principles; gates and runners are properly proportioned and properly set; also the pressure of metal entering the mold is so regulated by the height of the

reservoir above the highest point the metal attains in the mold, that by virtue of this pressure or head, coupled with the mass of metal in the reservoir, the feeding of all sections, light or heavy, continues until solidification is completed.

With these concerns the day of the chill has passed, and while a few must be used from time to time in extreme cases, even this will cease as soon as the designer awakens to the fact that slight alterations in his design will render their need unnecessary.

The Effect of the War

Do not lose sight of the fact that the changes brought about by the present conflict have had a profound influence on all lines of business, particularly in the manufacture of steel and iron products. It has necessitated the starting of many new plants as well as the enlargement of the old ones to the point of greatest possible production. This, coupled with the exigencies of munition and ordnance work has in turn necessitated the employment of a legion of men in the capacity of engineers and inspectors, educated for this particular purpose at the expense of the government. Many of these men would never have followed these vocations had it not been for the war, so where previously a limited number were familiar with the manufacture and characteristics of steel and iron, we will at the war's end have thousands of highly trained men who by that time will be very proficient, due to this varied and unusual experience; while those previously engaged in the business will be still better equipped as they will have had full advantage of this extraordinary opportunity.

All this, if it signifies anything at all, means that in the future we will be dealing with men who understand their business, and it does not need a prophet to forecast that all ferrous products from now on are going to be measured under higher and higher standards of inspection. Unsound castings are not going to get by, and he who thinks differently is most assuredly living in a fool's paradise. From now on there is but one safe road to follow and its direction is clearly indicated. The laxity that obtains in many plants in regard to these

most important and vital considerations should cease if they have any regard for their own well being or for the industry as a whole.

Perfectly Sound Castings

Our opportunity is at hand, because it has at last been demonstrated beyond a shadow of doubt that the most complicated malleable castings can be regularly produced by many concerns without a trace of shrink, and of a strength and ductility not thought possible some years ago. The engineer now knows this to be the case and knows as well that we have outgrown and made up for past misdemeanors. Discard the chill, and in its place substitute risers or heads of such height and section as will furnish sufficient pressure of fluid metal to make sure the casting's integrity.

Have some one on the job who understands this art and keep him busy with every pattern that needs attention. Impress him with the thought that he is the most important man in the place, which under conditions now existing is the case, and hold him responsible for any lapse in the direction of unsoundness.

In breaking hard iron castings in search for shrinks, do not assume that none are present until those thought solid have been annealed, because this treatment will develop a shrink not discernible prior to annealing.

In the malleable industry a new era has dawned, a fact frankly admitted and acknowledged by the trade. Let us stand shoulder to shoulder for mutual help in the matter of soundness. Let the integrity of the casting be the very first and foremost consideration, for a solid casting made of ductile metal having an ultimate strength of but 40,000 pounds per square inch, is unquestionably superior to one in which shrink is present though the test bars in the latter case yield an ultimate strength of 50,000 pounds per square inch and an elongation of 20 per cent.

Report of A. F. A. Committee on Safety, Sanitation and Fire Prevention

At a meeting held in Rochester, N. Y., July 12, 1918, by request of the American Foundrymen's association, regulations for the sanitation of foundries were prepared and these are now submitted as a complete and separate report.

Tentative regulations for fire prevention in foundries are also submitted herewith. These fire prevention regulations are merely tentative. In other words, they are to be the groundwork for the future deliberations of this committee during the coming year. They are not to be understood as the final word on the fire hazard in foundries.

Since the meeting of the committee at Rochester, N. Y., these two reports have been submitted again to all the members of the committee and a number of very good suggestions and criticisms have been received. As these criticisms and suggestions could not be incorporated in the code before this report went to press, it was deemed advisable by the committee to print these suggestions and criticisms following the sanitation and fire prevention regulations.

VICTOR T. NOONAN, *Chairman.*
RALPH H. WEST
DR. RICHARD MOLDENKE
C. E. PETTIBONE
EARL B. MORGAN
F. H. ELAM
T. A. SOULTS
FRANKLIN H. WENTWORTH
GEORGE B. KOCH

Sanitation Regulations for Foundries

Approved by the American Foundrymen's association committee on safety, sanitation and fire prevention at meeting held in Rochester, N. Y., July 12, 1918.

Rule I

a.—Water Closets

1.—Water closets shall be provided in every foundry for each sex, according to the following table:

Number of Persons	Number of closets	Ratio
1 to 10	1	1 for 10
11 to 25	2	1 for 12½
26 to 60	3	1 for 16 2/3
61 to 80	4	1 for 20
81 to 125	5	1 for 25

For every unit of 45 or fractional part thereof in excess of 125 employes an additional water closet shall be provided. Where water and sewage facilities are not available, sanitary chemical closets may be used.

b.—Urinals

1.—Urinals shall be provided in accordance with the following table:

Number of Persons	Number of urinals	Ratio
1 to 30	1	1 to 30
31 to 80	2	1 to 40
81 to 160	3	1 to 53 1/3

And thereafter an additional urinal to every eighty (80) employed. One individual urinal shall be considered equivalent to two (2) lineal feet of trough or slab urinals.

c.—Washrooms

1.—Wash basins with faucets for hot and cold water shall be supplied for each sex in accordance with the following table:

Number of Persons	Number of wash basins	Ratio
1 to 8	1	1 for 8
9 to 16	2	1 for 8
17 to 30	3	1 for 10
31 to 45	4	1 for 11½
46 to 65	5	1 for 13

For each additional fifteen (15) employes at least one additional wash basin shall be supplied. Twenty inches of enameled sink, or its equivalent in sanitary properties, shall be considered the equal of one wash basin.

d.—Shower Baths

1.—Shower baths shall be provided according to the following table:

Number of Persons	Number of showers	Ratio
1 to 50	1	1 for 50
51 to 100	2	1 for 50
100 to 200	3	1 for 66 2/3
200 to 400	4	1 for 100

For each additional two hundred (200) employes, one additional shower shall be supplied.

e.—Lockers

1.—Individual metal lockers arranged for locking shall be provided for employes, and shall be placed in a separate space for each sex and used exclusively for such purposes. This space may be located in either the washroom, the drying room, or at convenient places in the molding or core room.

f.—Drying Room

1.—Facilities shall be provided, in connection with either locker, wash or toilet rooms for the sanitary drying of workmen's clothes.

g.—Drinking Fountains

1.—Drinking fountains shall be installed at convenient places, and the use of a common drinking cup prohibited.

h.—General

1.—All the above sanitary provisions shall be conveniently located in a place accessible to and connected with the foundry so that the entrance thereto can be had without exposure to the open air.

Criticisms and Suggestions on Sanitation Report

From Mr. C. E. Pettibone, Pickands, Mather & Co., Cleveland, Ohio

a.—Last Paragraph—In addition to the sanitary chemical closets provided, you ought also to allow for septic tanks. These are recommended by the United States department of health and are commercially on the market and work out more satisfactorily in most places than the chemical closets, due to their withstanding rough treatment better. I would suggest that you prohibit range closets on new installations except where a continuous stream is used.

b.—We do not know of course how you arrived at the figure of two lineal feet of trough being equal to one individual. In actual practice we have found this distance to be about 3 feet.

c.—Wash Rooms—These require both hot and cold water. Many installations now are made with a constant temperature water of approximately 98 to 100 degrees. It is more economical and prevents burns. This system is used at the plant of The B. F. Goodrich Co., at Akron. We note you specify 20 feet of enamel sink as equivalent to an individual washing unit. The Wolff shower unit which we have used in some cases, and which is used exclusively by The B. F. Goodrich Co., has five units in an 8-foot length. You will see that this is somewhat under your requirements. It seems, however, to be entirely ample and I should not think you would want to draw your specifications in such a way as to eliminate this equipment. In considering these dimensions it should be borne in mind that it is possible to overlap at the end, so that the end shower is only half the distance from the end of the sink as the distance between the showers. In reality, therefore, you obtain the use of a longer space than the length of the sink.

f.—Does this section permit of the use of specially ventilated lockers for drying? A number of concerns are using various types of these lockers. We are using a locker espe-

cially designed by us which thoroughly dries the men's clothes and keeps them in a clean and sanitary condition, and which we believe is preferable to drying rooms. Their use is under conditions as severe as those of a foundry.

h.—Might it not be well to call attention to the desirability of considering the safety of employes in the route necessary for them to traverse from their work to the various sanitary provisions?

From Dr. Richard Moldenke, Watchung, N. J.

In regard to Mr. Pettibone's suggestions:

a.—Septic tanks are all right, and might be made alternative with chemical closets. Do not know exactly what range closets are, hence cannot suggest anything along that line.

b.—While Mr. Pettibone may have found three feet the proper figure, I would follow the figures used in the several state regulations.

c.—Constant temperature hot water regulating devices are fine—I have used them in institution work. They are, however, expensive and get out of order. I would not insist on them at present as they cost the little foundryman too much. Regarding the Wolff shower unit, what is the matter with the people making this getting the length according to our regulations, and not we stretching the regulations to suit them. Too many manufacturers to get trade make their product a little smaller than that of others. This should not be recognized in our regulations.

f.—Drying rooms are better than any old place for lockers. They can be watched and kept in good order and the men made to keep their lockers clean.

h.—Always good to have men reminded that they should watch their safety.

F. H. Elam, American Steel Foundries Co., Chicago, Ill.

a.—Last Paragraph—I note Mr. Pettibone seems to think that we should have included septic tanks in our regulations. My understanding of the septic tank installation is that it is

not primarily a closet installation, but is usually installed in lieu of a sewer in places where sewer connections cannot be obtained. With the septic tanks installed, the regular flush bowl toilets are used, so I do not feel that this criticism is very pertinent. We might call the attention of our members who have no sewer connections, to the advantages of septic tanks.

I am in sympathy with Mr. Pettibone's suggestion that we prohibit "range closets". I gather that he means by this, the open type of privy where there are no seats or divisions, and I rather thought we were covering this point by implication, if we did not specifically mention the matter.

b.—"Two lineal feet of trough equal to one individual."

The question is raised how we arrived at the figure of 2 lineal feet of trough being equal to one individual. I do not know where these figures were taken from at the time the code was first worked on, a year ago, but by reference to our company standards I find that all of our wash and locker rooms have been equipped with wash troughs installed as result of the specification which reads as follows: "The contractor shall provide and set standard porcelain enameled roll-rim wash sinks 27 inches wide with separate hot and cold water connections so arranged that men can wash on either side, as made by the Standard Sanitary Mfg. Co., their plate P-2683, or equivalent with quick combination faucets at *every 2 feet of sink* with connections for hot and cold water pipes, and so arranged that hot water is always on the left hand side of the user. Outlet from wash sink to be fitted with the Eclipse strainer. No stopper to be used which might retain water in sink."

c.—Wash Rooms.—Mr. Pettibone's remarks regarding our standards requiring both hot and cold water would seem to indicate that he does not think that this requirement is as good as a constant temperature of the water approximating 98 to 100 degrees. By requiring both hot and cold water, the workman is given an opportunity to use hot and cold water as he may desire, and where combination faucets are used, he can regulate the temperature of the water to suit his individual taste, which I think is a desirable feature.

He says: "We note that you specify 20 feet of enamel sink as equivalent to an individual washing unit." I think he is in error here, as we specify 20 inches of enamel sink or its equivalent in sanitary properties shall be considered the equal of one wash basin, and he seems to think we are referring to shower bath units, which is an error. This, however, brings to our attention the fact that we have not given any dimensions for the space to be provided for the shower bath. The enclosure separating each shower bath should be 3 feet x 3 feet x 6 feet 6 inches high.

f.—Drying room—It might be well to rewrite this section so that the employer would have an alternative of furnishing drying rooms or especially ventilated lockers for drying.

h.—General—I think that it was our intention to provide for the safety of the workmen when we stated that the various sanitary conveniences were to be conveniently located in a place accessible and to be reached without exposure to the open air. There is no reason why this section may not be made a little bit more explicit in regard to providing access to these various facilities with absolute safety.

T. A. Soults, Sill Stove Works, Rochester, N. Y.

a.—Referring to Mr. Pettibone's criticisms, Mr. Soults favors septic tanks and the prohibition of range closets in new installations.

b.—Two lineal feet of trough O. K.

c.—Mr. Soults favors faucets to deliver water between 75 and 100 degrees Fahr. to be supplied for each sex.

f.—Mr. Pettibone's inquiry on this is covered in the rule.

Tentative Fire Prevention Regulations

Tentative fire prevention regulations for foundries prepared by the American Foundrymen's association committee on safety, sanitation and fire prevention at meeting in Rochester, N. Y., July 12, 1918.

The committee wishes it to be understood that the following fire prevention regulations are merely tentative and are intended to be the foundation for more complete regulations on fire prevention in foundries. For this reason the committee

will welcome suggestions from members of the American Foundrymen's association.

1.—All foundry, pattern and storage buildings shall be of fireproof construction.

2.—All foundry buildings whether of fireproof construction or not shall be equipped with automatic sprinkler system.

3.—All sections of foundries devoted to the cupola, air furnace, converter, crucible, open-hearth or electric furnaces, shall be entirely of fireproof construction.

4.—Foundry cupboards should all be of metal construction.

5.—It is recommended that metal flasks shall be used in place of the present wooden flasks, as required, this being a step toward the conservation of wood and also a prevention against fires, within the foundries.

6.—All oils shall be kept within metal containers in fireproof oil houses.

7.—All foundries shall have organized fire brigades.

8.—Fire hose shall be used for fire prevention purposes only.

9.—Provide brigades with modern means for fighting fire.

10.—Keep fire appliances clean and accessible.

11.—See that stand pipes and hose are always ready for use.

12.—Hold brigade fire drills at irregular intervals, at least once a month.

13.—Have written reports of all brigade drills and fires.

14.—Have regular inspections made.

15.—See that electric wiring is kept in repair and not abused.

16.—Guard against spontaneous combustion in stock.

RECOMMENDATIONS

How You Can Prevent Fire Starting In Your Foundry

1.—Install the following appliances:

a.—Waste cans
b.—Safety cans.
c.—Metal ash cans.
d.—Fireproof lockers for employes.

e.—Wire guards on all gas and electric lights.
f.—Other fire prevention appliances.

2.—Forbid the use of "Strike-anywhere" matches.
3.—See that electric wiring is kept in repair and not abused.
4.—Guard against spontaneous combustion in stock.
5.—Get co-operation of employes.

What You Need to Fight Fire In Your Foundry

1.—Fire extinguishers.
2.—Soda and acid extinguishers.
3.—Water pails and casks.
4.—Bucket tanks.
5.—Chemical engines.
6.—Axes and hooks.
7.—Stand pipes and hose.
8.—Sprinkler system.
9.—Fire alarm.

Common Hazards That Imperil Many Plants

1.—Boilers, radiators and furnaces.
2.—Electric light, heat and power.
3.—Gas light, heat and power.
4.—Oil lamps.
5.—Candles.
6.—Torches.
7.—Dirty chimneys and flues.
8.—Static electricity.
9.—Spontaneous combustion.

To Insure Fire Appliances Being Ready When Needed

1.—Be sure to see all water and stand pipes are protected from freezing.
2.—Guard chemical extinguishers, pails, casks, etc., from exposure.
3.—Have extra charges for extinguishers always on hand.
4.—See that all employes understand use of appliances.
5.—Test fire pump regularly.
6.—Replace defective appliances at once.
7.—See that fire appliances are in their proper places at all times.

Suggestions and Criticisms on Fire Prevention Regulations

By Franklin H. Wentworth, Secretary, American National Fire Protection Association, Boston, Mass.

I can see that you have aimed at brevity but I believe that certain items should be somewhat amplified to insure clearness. A number of items in the same class would better, I think, be placed together; for instance, items 7, 12 and 13 might be made one item, also items 8 and 11.

We have found that all advice of this sort must be pretty clear and concise to be understood and followed. Item No. 9 suggesting private brigades be furnished with modern means for fighting fire, might be replaced by a statement of just what modern means for fighting fire are. Under No. 8 I would suggest that the word protection be substituted for "prevention." We cannot prevent fires with fire hose but we can extinguish them; the word protection is more inclusive. We have adopted the term "fire resistive" in all our literature in preference to the term "fireproof" as there is really nothing that is fireproof. Referring to Item 16, in what foundry stock does spontaneous combustion occur? It should be clearly indicated, I think.

Taking up the Recommendations: It might be well to add "for inflammable liquids" to "safety cans." Item F, under the first section seems superfluous, it would be better to state exactly what the other fire prevention appliances are. Under Item No. 5, Section 1, the sort of co-operation desired from employes might be indicated. Under section 2, what fire extinguishers are indicated under Item 1? Items Nos. 3 and 4 in this section might be combined.

Under paragraph 3, lighting and heating, might be considered common hazards but not "static electricity" and "spontaneous combustion." It should be shown, I think just where in foundries and by what devices static electricity and spontaneous combustion may be generated.

In section 4, does item 2 refer also to freezing? If not, against what exposures should chemical extinguishers be guarded?

By F. H. Elam, American Steel Foundries Co., Chicago, Ill.

I wish to suggest that instead of the term "fireproof" we substitute "fire resistive." I think that No. 6 might be made better by stating "All oil stores shall be kept within metal containers in fireproof oil houses," and his suggestion that there be a regrouping of items Nos. 7 to 16 to have them come in better sequence is a good one.

I think that his suggestion that No. 8 should read "Fire hose shall be used for fire prevention only," should be adopted. I think that No. 14 could be made stronger by reading: "Have regular inspections made for fire hazards." In No. 16 it would be better to eliminate the words "in stock," and have it simply read "Guard against spontaneous combustion."

In 1 (b) make it read: "Safety cans for inflammable liquids." Mr. Wentworth's criticism of what fire extinguishers should be indicated, I think has been covered by my letter dated July 24. His comments regarding paragraph No. 3 in regard to statical electricity and spontaneous combustion are only partially pertinent. I suppose by static electricity is meant electricity from lightning, and I really do not believe that there are any inherent hazards from that source. Spontaneous combustion, though, is a hazard, as fires may start from this source in the fuel supply and in the oil supply, especially in the oils used in mixing the cores. Linseed oil is very dangerous as regards spontaneous combustion if it comes in contact with rags, sacking, waste, or other substances, and spontaneous combustion is also a hazard where accumulation of oil and waste and oily overalls occur in tool cupboards and lockers.

I realize that if all the members of this committee send in comments covering Mr. Wentworth's criticisms, and also make some suggestions, that you are going to have rather

a difficult time separating the wheat from the chaff in re-writing this code.

I wish to suggest that Rule No. 11 be made more comprehensive by substitution of the following: "See that all fire fighting appliances are always ready for instant use," instead of, "See that stand pipes and hose are always ready for use."

I wish to suggest that Rule No. 14 be improved by having it read: "Have regular inspections of plant made for fire hazards."

Under "Recommendations" I wish to suggest that A and B could be incorporated in one suggestion, viz: "Metal Safety Waste Cans."

Under the recommendations "What You Need to Fight Fire in Your Foundry," I wish to suggest that No. 1, Fire Extinguishers, be made a subject with Nos. 2 and 5 and the two suggested items as subsubjects, as follows: A—Chemical Engines. B—Soda and Acid Extinguishers. C—Tetrachloride Extinguishers for Electrical Fires. D—Fire Foam Type Extinguishers for oil fires.

Under the title "To Insure Fire Appliances Being Ready When Needed," I would like to suggest that all fire extinguishers be sealed after filling or charging to prevent the contents being tampered with. This procedure would prevent the extinguishers being filled with volatile fluid, as reported as having been found to have been done in some of the Ohio plants.

The regulations, except as noted above, seem to be a very good compilation.

BY GEORGE B. KOCH, SOUTH ALTOONA FOUNDRIES, ALTOONA, PA.

I agree with Mr. Pettibone that septic tanks should be allowed, and with Mr. Wentworth that fire resistive is a better term than fireproof. Further I do not believe it is necessary to provide automatic sprinklers in the foundry, but they should be required in pattern storage houses and pattern storage buildings, if of any size, should be subdivided by fire walls.

Discussion—Safety Code

THE CHAIRMAN, MR. VICTOR T. NOONAN.—Three years ago this committee drew up a foundry code and incorporated sanitation. Such a code should have sanitary requirements. Last year at Boston, the National Founders' association made arrangements for a joint conference to be held at Buffalo. They got up a code in which sanitation was left out. The American Foundrymen's association instructed this committee to formulate a separate sanitary code and this separate sanitary code is included in this report. There is also a fire prevention code here which is merely tentative, it is merely the groundwork for future work along this line.

The Ohio foundry code, which includes sanitary requirements, was completed two years ago, and went into effect as a legal order on Jan. 15, 1918. When work was first started on that code there was naturally a good deal of opposition. It was feared that the state would not use good judgment in the enforcement of the code. Our factory inspection department, however, is receiving a great deal of co-operation from the foundries in Ohio.

The state realizes that the manufacturers are up against it now when it comes to placing requisitions or orders for sanitary and safety devices. It realizes manufacturers can not get them promptly. It may take a year, as it does in some cases, to secure such equipment. In that case it is up to the factory inspection department to meet more than half way the manufacturers and be reasonable in the matter of placing orders. We find that when our department is reasonable in the matter of making factory inspections we get a great deal more co-operation. On the other hand, the man in whose hands rests the responsibility of enforcing state factory laws, has to distinguish between the employer who is careless and the man who uses the war as a reason for not complying with his obligations.

I should like to have a motion from some member of the American Foundrymen's association that this safety report be adopted or approved or some action taken on it. I should suggest that the fire prevention report be sent back to the committee for further study and for completion.

Voted, upon motion duly made by Mr. J. B. Garber, Salem, O., and seconded by Mr. Schmidt, Milwaukee, that the report of the committee on the sanitary code be adopted and that the fire prevention code be referred back to that committee for further study.

Accident Prevention is Good Business

By Fred M. Wilcox, Madison, Wis.

I question whether any considerable number of thinking people in this day would take the position that accident prevention is not of real benefit. It pays, not necessarily alone in dollars, but in other benefits that are perhaps of greater benefit. And still we do know that there are concerns that do not believe in accident prevention, they scoff at the idea of safety first movements. This is true largely with the smaller manufacturers, you do not find such a belief held by the larger employer. This is probably due to the fact that the smaller employer does not have the experiences in his own factory that call the result of a safety first movement to his attention as it does in the larger plant. He may employ 50 men, while across the street is a large institution that employs thousands of men. He hears of serious accidents in this large plant and feels that they do not occur in his factory so that he does not need any of this safety first movement. He does not appreciate the fact that he has the same ratio of accidents in his plant, in fact, a larger ratio than they have in his neighbor's plant. We know that to be a fact.

It is my privilege to be a member of the workmen's compensation insurance board in Wisconsin. I have had to do with the making of the rates, had to do with the establishment of premiums that all compensations are carried on.

Not all employers believe in safety first. I can demonstrate that by going into many plants and I can find written on our safety first bulletins all sorts of scurrilous inscriptions. Who put them there? The employes did. They were not appreciating the safety first movement. They did not see the benefits coming to them. How do they get that attitude? It

is my impression because they never hear anything about safety first except as applied to the workman himself. All the lecturing that is done is the lecturing of the employe, not of the superintendent, not of the foreman, not of the men who are driving this affair, the direction is all for the man who is going to be injured.

I was discussing with an insurance man in this state not long since the question of bulletins they were posting in the plants. Every one of them contained directions to the men, nothing to the superintendent, nothing to the foremen. Now this insurance company was insuring the risk of an employer and he was interested in safety in that plant and I insist that those bulletins that are posted on the boards ought first to be directions to the foremen and superintendents.

Begin at the Top

You leave a bitter feeling with these workmen if they think these directions are for them alone, for safety first begins at the top of a plant. If the president is opposed and thinks there is nothing in it, then there is no safety in that plant. The only way you will have a real safety first movement in the plant is when the heads of the institution are in the game.

Less than a year ago, a coal dealer from one of Wisconsin's cities, refused to do any safety work, refused to put any sanitary devices in his plant and we called him up on the carpet at Madison. He got in there on Saturday morning about 10 o'clock and he proceeded to tell us all he knew about his business and what he knew about ours. He took the attitude that he was absolutely opposed to a decent and safe place for his men to work in. He went on to say he never had any accidents, and he told us how a certain insurance company was getting rich off his business, how he paid so much to them and never got anything back. He took a fling at us. He insisted that it was not necessary that he do anything.

We made inquiry and we found a man had fallen from a height and had been injured because this dealer did not have a device at that particular point. All his men were I. W. W.'s, all his men were drunkards, he could not get anybody else. On the following day—now this is not a story fixed up for the

occasion—some man who had to do with a boiler in that plant went there to do some work. It was Sunday and the work could not be done as well on another day. While he was left alone he fell and struck on the bench or some other part of the equipment. He broke from 11 to 15 ribs, his skull was crushed, he was jammed up completely. The watchman coming along found him and took it for granted that he was drunk. This man had the president's viewpoint that everybody was drunk. He kicked him awhile and then covered him up with a blanket. The next morning they lugged him home in an ambulance and later that same forenoon they found him dead. When the doctor got there he found the horrible condition this man was in.

It then cost this insurance company $3000, or more premiums than they will collect from that institution in the next 20 years. So that shows what can come from the wrong attitude on the part of the management and it shows just what the feeling is on down through the men in those same institutions.

Possibilities of Safety Movement

It is a bit hard to say just how much can be accomplished by a safety first movement. The figures have been variously estimated. Some safety men put those figures up so high they rather stagger me. Some institutions that got in as pioneers on the safety movement rate the reduction at 40, 50 or 60 per cent. It is unlikely that such reductions will be made now because we have gone a long way since those days.

The safety first movement is not over 10 years of age. What have we done in that time? We have covered up the exposed shafting, the exposed gear, we have done away with keys that stuck out, the belts that were exposed. We have done a volume of things that is calculated to reduce the accident experience in this state. We have gone in some plants to the full limit so far as mechanical safeguards are concerned. The safety possibilities and the accident prevention possibilities in a plant so far as mechanical safeguardng is concerned probably will not do away with over 20 per cent of the accidents.

The great bulk of accidents, the large per cent of them must be met by something else—they must be met by education. Some one said recently that it is a matter of the heart. You have got to inculcate into the minds of every superintendent, and the foremen and the men themselves, the thing for them to do is to be careful. Then they will avoid these injuries.

It has been the experience in Wisconsin that as many accidents occur from falls and falling objects as occur on machinery. Now, very largely those accidents may be overcome, at least in the plants. You will still have them out in the lumbering camps because they do not expect to avoid falling there. Education will not keep the man from slipping in a dangerous place, but the large bulk of the accidents, of the falling kind, may be overcome by care on the part of the employer and care on the part of the employes.

New Men More Liable to Injury

Accidents are frequently occasioned by ignorance of the character of work the person is set to do. We find the great bulk of them falls upon the man who has only worked a few days or a few weeks. Our experience shows that 70 or 80 per cent of all accidents occur to the man who has worked less than three months. They frequently occur, too, to the man who has just worked two or three weeks and when you go up to three weeks you have the great bulk of them. They practically all occur to the man who has had little or no experience—especially when he is working around machinery. That is particularly so now when unskilled labor is put at jobs operating machines they never operated before. The results are serious. They are not accustomed to these machines. They ought not to be at that class of work without more experience than they have had.

Then there are the accidents arising from pure carelessness. How to avoid these is always the problem of every employer. Some men are born careless and they will never get over it. They will die as a result of their carelessness. You may never be able to make these men realize the fact that their carelessness is a continual hazard not only to themselves but to those who work with them.

A large part of such accidents could be overcome, such as those occurring from throwing a board down with a nail sticking up, when a little bit of education will make the man take those nails out. Then there are unsafe conditions that exist at the plant, obstructed alleyways or passage ways, holes in the floors, floors that are not level and that conduce to slipping and stumbling—all those things lead to accidents. Others are caused by poor light. There is always a rise in accidents when you come to the winter months and when you come to deal with artificial rather than natural light. There is an increase of hazard in the plant that is poorly lighted over the one that is well lighted. Most of these causes could be largely overcome either by mechanical safeguards or by correcting dangerous conditions under which the men work.

With regard to costs, in 1915 the industrial commission of Wisconsin promulgated and issued a bulletin of our past accident experience covering 40,980 accidents. In 1914 we had 1100 or 1200 accidents in this state. We covered 11,157 accidents which represented 285,000 working days; that is 950 years, 300 working days a year, 10 hours in a day. And Wisconsin's does not equal that of a big industrial state like Ohio. But expressed as equivalent to 950 years, 300 days per year, you will get an idea of the cost.

Now, the experience for the years 1915, 1916 and 1917 showed 40,980 accidents. I know figures are not altogether satisfactory but I would just like to give you these because they will carry a lesson back to you. Those 40,980 accidents represented 5,951,838 working days, or 19,839 working years of 300 days per year, 10 hours per day. They represented three Allis-Chalmers plants working a full year.

Filling a Labor Shortage

If you could release in the city of Milwaukee today the number of men that represent the working power lost in accidents each year in Wisconsin, there would be no labor shortage.

In Wisconsin during the last year, we had 19,361 accidents, that is accidents that disable men more than one week, I am not speaking of the 30,000 or 40,000 accidents that cause

disability of one, two or three days. The past year's accident record thus shows lost time of 2,807,000 working days or 9,358 working years.

These records show something of the loss of manpower, in addition to the money loss. Almost all the industries of Wisconsin are under the compensation act. There was paid out during the last year, and that does not include the full 19,361 accidents, $1,705,468, or an average of $108 per case, indemnity and medical benefits in this state. There has been almost $7,000,000 paid out in Wisconsin since this compensation act came into effect.

These figures do not begin to compare with the amount of money that is expended in the states of Ohio, New York or Pennsylvania where industrial activities are so much greater. But those millions of dollars are paid out by employers in benefits. When it is remembered that 60 per cent of all industries are insured you have to add to that a loading charge that insurance companies collect in order to carry the liability. Out of every dollar they collect they pay back about 60 per cent in benefits and medical attendance, the balance of it being used for their own expenses. When you stop to take account of these figures you are actually paying a much higher amount than compensation and benefits would indicate. And that is not all of it. In the state of Wisconsin our maximum upon which compensation would be based is only $2.50 a day, so that even though our rate is 65 per cent we are actually paying back to the insured man and his dependents less than one-half of his wages. The balance of this is being borne by the injured man.

Some other states are doing more for their workmen, for their employers, than Wisconsin is doing. The state of Ohio does more than any other state in the union. She gives more to her employes and employers so far as compensation is concerned than any other state. She protects by large indemnities. She gives to her employers their insurance carriage and actual cost.

Injured employes carry all the pain and suffering from accidents—that is another element that ought to be considered.

I have dealt with the proposition of cost, approximately one-half of which is borne by the employer, shifted back on

to the industry, and the other half by the employes. That is the actual money loss.

Cost of Labor Turnover

In addition, an accident means a new man must be put in the injured man's place. Accidents forced in the state of Wisconsin in the last year a labor turnover of 19,361 at least, and it forced perhaps a labor turnover in some other states of 30,000 or 40,000. Labor turnover is a serious matter. Figures show that in the steel and metal trades labor turnover, that is the training of one man, costs something like $40. Other estimates place the costs at $50. Accidents not only force labor turnover, but labor turnover forces accidents. If you put a green man in the skilled man's place accidents happen, so you have that continual gnawing from both ends that ought to be avoided.

I think it goes without saying that accident prevention does pay. It pays from the standpoint of the employes, it pays from the standpoint of the employer, and from the standpoint of the public. It ought to be encouraged at every point and it ought to be encouraged from the top down. It ought to start with the heads of the institution.

Discussion

THE CHAIRMAN, MR. VICTOR T. NOONAN.—I want to emphasize the lack of interest in accident prevention. When you pick up your daily paper you are horrified at the number of casualties occurring among the soldiers in France. Yet our industrial accidents continue to be higher than the casualties occurring among the American troops in France. In the first year of our war, 85,000 Americans were killed. They were not fighting in the trenches of France, they were not fighting to

protect the flag, but they were killed in all kinds of accidents in the United States.

Our industrial accidents in this country at the present time are equal to the United States having a fighting force in the trenches of 2,700,000 men, not an army of 2,700,000 men in France, but 2,700,000 men fighting in the trenches of France. It is the experience of the industrial commission of Wisconsin and it has been the experience of the industrial commission of Ohio, that the largest number of workers injured are all within the draft age. In Ohio the largest number injured are between 25 and 41 years of age. The matter of accident prevention begins at the top with the manager. It is a mistake on the part of those who think it begins at the bottom with the workman. The workman is equally responsible, he has moral obligations. He had them before the war and he has them highly intensified since the war began. A moral obligation is a patriotic duty in these days—every workman must do his best to safeguard his fellow workmen—to give his best production to safeguard not only himself but his fellow workmen wherever he may be working. But accident prevention begins with the manager. It begins at the top and works down through the ranks.

The management is responsible for production, it is responsible for the entire plant and it is equally responsible for the men and women who work in the plant. In those plants where I have found real accident prevention, where the accidents are being reduced, where co-operation exists between employer and employes, it has been due in every case to the personal interest of the management in the men.

Last year, I conducted a survey in about 500 of the larger plants in Ohio, to find out first of all if accident prevention work was bringing results, if it was worth while. These 500 large plants were making a study of accidents and their causes, endeavoring to prevent them. In the questionnaire, one question was, "have you any committee among your employes? Do you get any result from them? Are you reducing any particular class of accident, such as infections, or burns, etc.?"

In every case the replies came from the president or vice president or general manager. The companies seemed to

look upon this subject as something of importance. In 90 per cent of the replies I found the accident reduction in these plants was anywhere from 25 per cent to 75 per cent. In every case where accidents had been reduced it was due to the fact that these companies had safety committees among their employes. This is evidence that organized safety committees in a plant, whether steel or wood working, are doing good work. If you have a safety committee making inspections once a month or twice a month they will find many hazards which they can eliminate and which will help to overcome accidents.

In Ohio, where we have between 26,000 and 30,000 industries, the most frequent accidents occurred during the past four years from falls and falling objects, not from machinery. More men get killed and disabled by falling off ladders, falling off chairs, falling down stairs where there is not sufficient light, falling off platforms where the handrails are broken, or falling on slippery floors, than by machinery. All of these hazards are not dangerous yet they are killing and disabling men. Of course, if you went through a foundry and saw a man sitting on a keg of dynamite smoking a pipe, you would throw him out. If you found him on a broken ladder, you would pass by because you would not recognize the hazard.

Accident prevention is an affair of the heart. Your state code, your sanitary code, your state factory inspection committee, your warnings on factory walls, are all good, your talks to your men, the efforts your foremen make are good, but not sufficient without the heartfelt interest of the management. Years of experience and observation have taught that. The manager must be sincerely interested in the men who work in his shop.

Safety and Efficiency Facts and Figures

By C. W. Price, Chicago

As I understand it I am to place before the American Foundrymen's association, not the humanitarian side of the safety movement, but the safety movement from the standpoint of efficiency, from the standpoint of dollars and cents; and, in presenting this—what may sound like the cold side of the safety movement—I don't want to be understood as minimizing the humanitarian side of the movement. But, we have been talking about the humane aspects of this question for a hundred years. It may, possibly, be somewhat new and interesting to all of us to consider what this movement has come to mean from the standpoint of efficiency, from the standpoint of profits.

I remember while I was with the Industrial Commission of Wisconsin, one day I went to the Simmons Mfg. Co., the largest brass bed manufacturing plant in the world. Mr. Simmons, the president, is a young man about fifty, a live, successful, American business man. I had never met Mr. Simmons before, and as we sat there, talking, he turned to me and said this very significant thing: "Mr. Price, I believe the time is fast approaching when it will no longer be possible to work any of the great revolutionary economies in industry that were brought about with the invention of the steam engine, by the discovery of the application of electricity, and by the discovery of the process of making steel; I believe the next great field in economy in industry is the conservation of the human equipment in our plants." Mr. Simmons has testified to the faith that is within him by making his plant one of the model plants of Wisconsin. For instance, they had a large foundry in which were employed some 550 men, pouring these

little castings that join the rods on cheap bedsteads; the roof was very low and gas conditions were very serious. I know many times during the summer they would have half a dozen men prostrated from gas. They spent $43,000, raised the roof of that foundry to some 45 feet in height, made it a model from the standpoint of light and ventilation, one of the finest foundries I ever saw; they reduced the number of men from 550 to 450, and they so increased the efficiency of that foundry that they saved the $43,000 the first year. I think that is one of the finest examples of the efficiency of good sanitation that I have ever seen.

The Road to Ruin

Now, in my work as field secretary I am meeting general managers every day; I suppose I met 500 general managers in the plants of Wisconsin and spent from a half hour to two hours in their offices; and I want to say to you, gentlemen, that managers everywhere—and most of them are young men of fifty years of age or younger—are waking up to an appreciation of the value of the human equipment in their plants. I hear it every day; it is coming to be a commonplace. Manufacturers are waking up to a realization of the fact that any manufacturer who deliberately pursues a course that disregards the rights of his employes to live their lives, to preserve their limbs and health, to be contented and happy, whether he knows it or not, is pursuing a course that at last leads to loss and inefficiency.

I want to give you the figures that prove that statement—and most of them are very recent figures. First, I want to give one figure that came to my attention from the bureau of statistics at Washington, which is very significant. This report went on to say that in the United States right now there are 38,000,000 wage earners and out of that 38,000,000 wage earners every 12 months—every 365 days—there are 25,000 wage earners killed by industrial accidents; that is 83 wage earners killed every day; 83 killed yesterday, 83 will be killed today. I tried to picture the thing to myself, Mr. Chairman, the other day and make that 25,000 real to myself. I said, "Let's bury that 25,000, as they bury those poor soldier

boys over in Europe, shoulder to shoulder, allowing about 2 feet per man, and see what it will come to." I took out my pencil and it figured 9 miles and a half—a trench 9 miles and a half long, and in the bottom of that trench a solid sidewalk of human bodies every year in the United States as the result of industrial accidents. And this report went on to say—an entirely new figure to me—that there are 700,000 wage earners that are so seriously injured that they lose over four weeks of time, 2333 each working day.

But I want to give the bright side of the picture, to show what has been done in reducing accidents, and the economic gain which has come out of the work along safety lines. The first company I want to give you is this: I was at Rochester the other day, and for a long time I have been aware that the Eastman Kodak Co. has been doing exceptionally fine work, but they refused to give me any figures as to what reductions they had made in accidents or what savings in money they had made. I met Mr. Robertson. He took out a sheet of paper from his desk, which was divided up into five sections, showing details of the accidents for five years; that report revealed the fact that during five years the Eastman Kodak Co. has reduced its accidents 80 per cent, as compared with its record prior to that time.

One Company's Record

Here is another interesting figure that came to my desk three months ago. I have been connected with the International Harvester Co. and it was my lot to be engaged with that company during the early days of safety work; and I was also employed as a department head in the old McCormick factory, and I know something of the old conditions. The Harvester company was the second company, I think, in the Middle West to take up safety work in a thorough-going manner. Here are the figures they gave me covering the last five years' experience: They have reduced deaths in their 23 plants 60 per cent; and—keep in mind—those 23 plants include coal mines, iron mines, railroads, logging camps, all kinds of machine shops and woodworking shops. Included in the International Harvester Co. you have practically every kind

of a hazard you have in the state of New York. They have reduced deaths 60 per cent, they have reduced the hours lost per man 61½ per cent, and they have cut the actual cost of compensation from 54 cents on a $100 payroll to 25 cents on a $100 payroll. If you will look it up I think you will find that that is about what a clothing store has to pay for liability insurance. So you have that great Harvester company, with all that hazard in those 23 plants, so reducing the cost of compensation that it costs them practically what it costs a clothing store to carry liability insurance. That one figure—25 cents—gentlemen, really indicates what that company has accomplished; and that figure, gentlemen, to me is one of the most significant figures which I have found, because that company more nearly represents the average hazard that you will find in all industries, and, therefore, represents what is possible. If the International Harvester Co. can do it, any company can do it.

Here is another instance—the Dodge Mfg. Co., which manufactures transmission machinery, representing an average hazard—just gave us these figures. They have reduced the cost of compensation and medical service, which includes the entire cost of accidents, from 50 cents on a $100 payroll to 7 cents on a $100 payroll. I don't know what the premium would be on a millinery shop, but I imagine it would be more than 7 cents. Think of it, a big machine shop and factory reducing the hazard to 7 cents on a $100 payroll!

As you know, the United States Steel Corp. has 25,000 men working in its mines and steel mills; it is probably the most hazardous industry in this country, and it was the pioneer in safety work. This great concern has done more to teach other manufacturers and has been more generous in its contribution toward the safety movement than any other corporation; and it is one of the leaders in safety work in getting results. They gave me this figure, using 1906 as a basis and comparing the years since 1906 down to the end of 1915 with the record in 1906. They have saved 14,967 human beings from either being killed or so seriously injured that they lost over 35 days time, as a direct result of their safety work. Now, I picture that to myself in this way: that would mean a city of a hundred thousand human beings—men, women and children—in

which city the father of every family, the head of every home, had been saved from either death or serious injury since 1906. Now, do you think, ladies and gentlemen—that the United States Steel Corp. will ever go back to the old days? I want to say to you that safety is put on the map in that company so it won't blot off; safety is recognized in every one of the plants of that company as an indispensable part of the manufacturing organization; and the head of every department is expected to make a record on that just the same as he is expected to make a record on any other thing that makes for efficiency, absolutely.

The Spirit of Co-operation

I want to give you another figure: I spent five years in Wisconsin, and I am rather proud of Wisconsin, so you will pardon me if I brag a minute now. But the Wisconsin experience is significant, because it covers an entire state. If you are familiar with Wisconsin, you know there are large logging interests, large woodworking plants, and many large machine shops like the Allis-Chalmers and International Harvester Co., and steel plants. In the state of Wisconsin, in the last five years, the manufacturers have reduced the deaths 61 per cent, by actual record from the industrial commission's report. And here is a very interesting figure: During the year just before the industrial commission came into existence, according to the report of the old industrial commission, there were 365 manufacturers dragged into court and prosecuted for violation of the safety laws. During the first five years there hasn't been a single manufacturer prosecuted in the state of Wisconsin on account of violation of the safety laws. The figures reveal the fact that there has been a spirit of co-operation in Wisconsin among the representatives of labor, representatives of capital and the industrial commission.

Take it in machine accidents alone. The records of the industrial commission show that accidents happen at points where something in the way of a mechanical guard could have prevented them. By the installation of mechanical guards alone the number of accidents was cut in two in five years; that is, there are now one-half as many accidents on mechanical parts

in Wisconsin as five years ago; that shows that some guarding has been done. For instance, in Milwaukee, in 1901, there were 22 accidents on elevators and six deaths; in 1915 there were two deaths on elevators, one of which was a suicide. This reduction was largely accomplished by the mechanical device.

I wish to give you one figure from the Kimberly-Clark Co. of Wisconsin. This was the first paper mill in the state to get started in safety work, some four years ago; and through their influence every paper mill in the state of Wisconsin is now doing good safety work. A few months ago I visited this company, and as I entered the door of one of the plants, I noticed a piece of paper on the wall, and I went up and read it and found this report: that in two of their mills during 12 months up to that time they had had just two accidents and neither of them cost compensation; that is, neither of them caused a disability of over seven days. The treasurer of this company stood up at a meeting of the paper men and said: "Gentlemen, if we had never prevented an accident in our company, the change in the attitude of the officers toward the men, and the change in the attitude of our workmen toward the company, which has resulted from the workmen's safety committees which have been organized in all our plants has more than paid us for every dollar we have invested."

Some Interesting Figures

Here is an interesting figure—you will notice I am sticking to my text and giving nothing but figures, and I am going to keep right on. The Chicago & Northwestern railroad appointed 600 workmen on its committees and these committees brought in 6000 suggestions on danger points; and from that number all but 200 were considered good by the company and carried out. The Northwestern railroad during the first years reduced deaths of employes 65 per cent; and so remarkable were the results, and so quickly were they realized, that every great railroad in the United States—starting with the experience of the Northwestern—has organized an accident department and is pushing safety vigorously, and is backing it with millions of money. Taking all of the railroads in the United States during the last five years, they have reduced

the numbers of passengers killed in wrecks 50 per cent—just one-half as many passengers killed in wrecks as were killed five years ago, according to the official statement of the interstate commerce commission.

They have reduced the number of train operators—brakemen, engineers and conductors—killed 47 per cent. And here is a still more striking statement: During the year ending June 30, 1916, there were 325 railroads—that includes some of your big systems like the Pennsylvania, New York Central and Northwestern—there were 325 railroads with 162,000 miles of track, and carrying 485,000,000 passengers, that didn't kill a passenger in a wreck. Now, gentlemen, that is the most remarkable thing that has happened in the history of safety; and if there is any doubting in this audience—if there is any man that doubts the practicability of this safety movement—all he has got to do is to contemplate for a minute the significance of a movement which, within five years, can command the attention of the officers of every great railroad in the United States, and can gain their confidence so that they have backed the movement with millions of money, to appreciate what there is in this safety movement.

A little while ago I was in Omaha, and while there I visited the American Smelting & Refining Co., employing a thousand men, most of them humble Italians. I should say that this smelting plant is a little more hazardous than an ordinary foundry, and a little less hazardous than a steel plant; it is a hazardous plant. As I entered the door through which the men go to check in for work, I noticed a long blackboard, about 15 feet long and 6 feet high, which was divided into two sections. On one section was the record, month by month, of the accidents in 1915; on the other was the record, month by month, for 1916. That blackboard, gentlemen, revealed this remarkable result: They had reduced the actual number of hours lost by those thousand men 90 per cent; I mean they had just one-tenth the amount of time lost during the corresponding months in 1916 as in 1915, and they had reduced the deaths 100 per cent, and they had reduced the number of accidents 70 per cent. Any accident was tabulated as an accident if it caused a loss of over 24 hours of time. And

here is a more remarkable statement than all. I was there on Oct. 27; if they ran four days more they would have gone through the month of October without a single man out of the thousand men being sufficiently injured to lose over 24 hours' time. I told them to write to me if they made the record. I got a letter a few days later saying that they made it. I have never seen anything like the pull-together spirit there was in that plant between the foremen and the workmen; the day I was there every foreman had his shoulder to the wheel and it seemed to me that every workman in that plant was vitally interested in making a record for his department. That experience to me was one of the most revealing and encouraging things I have seen in my eight years of safety work; and, Mr. Chairman, it revealed to me the possibilities there are in this safety movement; when the head of every department puts his shoulder to the wheel in earnest and gets his workers with him.

The Vital Importance of Industrial Accident Prevention in War Time

By Victor T. Noonan, Columbus, O.

The American Foundrymen's association at this meeting should consider and devise some plan to bring home to all its members and their employes in the United States and Canada the very vital importance in these war days of conserving manpower—in other words, more fully protecting human life and limb and reducing industrial accidents to a minimum. It is now as clear as daylight to all who have given any thought to accident prevention, that at least 50 to 75 per cent of the accidents occurring in workshops and factories can be eliminated. The splendid accident reduction experience of the United States Steel Corp. and of thousands of individual plants throughout the country, has proved beyond the shadow of a doubt the great possibility of preventing both fatal and nonfatal accidents.

State Survey of Accidents

During the past year the department of safety of the industrial commission of Ohio has conducted a survey in about 500 of the larger industries of the state with a view to finding out definitely what results were being obtained by organized business-like safety work. The survey shows that where accident prevention is a business-like department thoroughly organized with workmen's safety committees, and where the number, cause, frequency and cost of accidents were carefully kept and accidents investigated, there was a reduction of anywhere from 25 to 75 per cent in the number of accidents reported since these companies had commenced their accident prevention work.

In spite of the good work that has been accomplished along safety lines much more can be done. I am glad to say that war has given the safety movement throughout the country a much needed stimulus. It has become apparent that for every soldier we send to the trenches we must protect and safeguard at least 10 workers in the factories. When one of these workers is killed or disabled by industrial accident the loss of that worker to the country to my way of thinking is 10 times greater than if one of the boys in the trenches had been killed or disabled. Accident prevention, therefore, should be a very important war activity, in fact, it should be one of our most important war activities.

Accident Prevention and Patriotism

Employers and workmen alike must consider it the highest patriotic duty to do everything possible to prevent accidents. Every fatal accident, every eye lost, every hand or foot crushed or amputated, in a word, every accident that occurs to a worker is just as much of a victory for Germany as if those workers had been disabled by German guns. On the other hand every accident prevented is a glorious victory for the Stars and Stripes. It is a victory also for better living, better citizenship and happier homes.

Industrial accident prevention, therefore, gives us a great opportunity to make the industrial life of our country a safer place to work in. Industrial accident prevention will not only teach men and women to be more careful but it will teach all the workers as well as employers how to think. It will teach them to be more industrious, more thrifty, more sober and more upright. Industrial accident prevention will also give all of our people a higher appreciation of the value of human life and limb and surely in these days when life and limb is held so cheaply, that higher appreciation is sadly needed.

No industrial organization can do more to promote industrial accident prevention than the American Foundrymen's association in United States and Canada, working as a body and also each foundry working individually.

In Ohio during the past four years considerable educational accident prevention work has been accomplished, including: First, through meetings of employers, superintendents and foremen; second, through meetings of employes; third, by safety exhibits; fourth, by safety commission pictures illustrating the cause and prevention of accidents reported to the commission; fifth, by safety bulletins and other literature; and sixth, by a study of the accident experience of individual plants or groups of industries.

The Personal Interest of the Employer is Necessary in Accident Prevention

By Victor T. Noonan, Columbus, Ohio

Many years of active accident prevention effort has absolutely convinced me that the *personal heartfelt interest of the employer is necessary* if he wishes to conserve the lives and limbs of his employes. In other words, personal tact is necessary if one wishes to succeed in securing the best co-operation from employes in accident prevention or anything else. Many a big business has been built up on a solid foundation on this principle, and on the other hand, many a business has gone on the rocks just because this principle was neglected.

In observing the best accident prevention results in the industries of Ohio, I have always noticed that personal tact in handling employes, in other words, *the personal interest of the management* was responsible for winning the best results in the prevention of accidents. After all, accident prevention is an affair of the heart. The employer who pays as much attention, if not more, to the human machine, the man, as he does to the machinery in his plant, is more apt to get the right results.

Andrew Carnegie, once said, "You can take away all my money and all my property, but leave me my organization, my employes, and with the help of these men and women, I will replace all that you have taken from me." Andrew Carnegie knew as well as any man, that any business can't be brought to the highest success without the co-operation of every man and woman in the organization.

How, therefore, can any employer expect to reduce accidents in his plant unless he gives the same personal interest to that problem that he does to production, advertising and profits?

I know a big department store that went to the edge in bankruptcy simply because the superintendent of that store used no tact in dealing with the employes working under him. He didn't understand them, and he didn't want to know them. He discharged them without sympathy, with the result that the thousand men and women in that store were not co-operating to make it a success. A new superintendent, a man of common sense, tact, and sympathy, inside a few months, brought about a wonderful change.

The following instance will perhaps best illustrate what I mean by personal interest in accident prevention—in other words, the personal tactful plan:

In one of our large mills here in Ohio, one of the workmen reported one day for his pay check under the influence of liquor. He was sent to the superintendent's office, who told the man to report the next day, when he was sober. The workman returned next day, not in the very best of temper, and after getting his pay check, abused the superintendent.

The superintendent said to him "Now Jerry, I am not going to discharge you, but I am going to send you home for two weeks. If during that time you wish to come back and talk it over with me, I will be glad to see you."

Jerry went out very indignant threatening never to return. In the course of a few days he came back, and when he appeared in the superintendent's office, that official said to him: "Jerry, I want you to take my chair here, for the time being you are superintendent of this plant, and I will take your place. You know what our company's regulations are regarding employes drinking, and you know that I have disobeyed its regulation, and in addition have abused the superintendent. What should you do with me?"

Jerry replied, "Well, sir, I would have to discharge you, and I would hate to do that."

"That is exactly the point," said the superintendent, "that I want to bring home to you. I would hate to discharge you or any man, and yet some of you fellows don't see the point. Don't you know that I am not asking you to live up to any rule that I don't live up to myself?"

The logic of this splendid superintendent's argument shot home, and since that time there has been no trouble with Jerry.

The Story of the Watch

The same superintendent found a man neglecting to wear his goggles while chipping. Going up to this workman he said, "Joe, have you got a good watch?" Joe proudly took out a gold watch and showed it to the superintendent. "How much did you pay for this?" Joe replied, "Well I guess this watch cost $50." The superintendent said, "How much will you take for it?" Joe replied, "I would not sell this watch because it was a gift from some of my friends and I wouldn't part with it for anything."

"Now Joe," said the superintendent, "Would you take this watch and open the case and leave it on the bench exposed to flying particles, while you are chipping?"

Joe was very indignant at the suggestion, and said he would not think of being so careless as to endanger his watch in that way.

"Well Joe," said the superintendent, "You take care of your valuable watch, and yet on this very job you expose your eyes, which are far more valuable by failing to wear your goggles. Which do you want to save more, your watch or your eyes?"

Joe answered that question by faithfully wearing his goggles thereafter.

The following story proves how one employer reached the hearts of his workmen, gained their co-operation and brought about a remarkable reduction of accidents in his plant. I am giving this story now as a forerunner to some other phases of accident prevention to which I intend to refer later.

A year or two ago I happened to visit a steel plant employing about a thousand men. I asked the manager what results he was getting in his accident prevention work, whether accidents were increasing or decreasing. He turned to his desk and brought out some accident records and showed me that his company had made a reduction in serious accidents of 20 per cent and in minor accidents a reduction of 25 per cent, a total of 45 per cent for the year.

I considered this an extraordinary reduction in the plant accidents and I knew there must be some reason, I had never heard of the company doing accident prevention work, and the splendid reduction in accidents aroused my curiosity. During my visit to the plant I questioned the manager to find the reason for the prevention of so many accidents and before I left the plant *I found the real reason.*

The Real Reason

On the particular day that I was there we had our Ohio safety car in the yards of the plant and all the workmen had gone through it. Before I left the plant, the manager said to me, "Mr. Noonan, when the foremen were going through the car, did you notice a tall, gray-haired man?" I said, "Yes." He then told me the following story about the man:

"That man is one of our best foremen, but he used to drink considerably. One day I met him and I said, 'George, I'll bet you a $5 new hat you can't keep sober for three months.' George took up my bet and kept sober for three months, and won the new hat. That very day he went out and got drunk again.

"Several days later I met him in the plant and I said, 'George, that was a nice way you celebrated your new hat.'

"He said, 'Yes sir, I am ashamed of myself.'

"Then I said to him, 'George, can't you keep sober for a year?' And George kept sober for a year, and then took to the booze again, and so he continued for a number of years.

"One morning George came into my office and said, 'I would like to get off today.'

"Why?" I asked.

" 'The landlord is going to sell my house and I must move out.'

"I then said, 'Do you like the house where you live?'

"George said, 'Yes.'

"Why don't you buy it?

"George replied, 'I have no money.'

"I then pointed out, 'You have spent it all on liquor.'

"George said, 'Yes, sir, I realize what I have done and I know I ought to have the money now to buy a home for myself.' "

Here is the climax to the story. Before George left that employer's office, the boss had arranged with a bank for a loan to buy the foreman's home, and when George went home that evening his wife was a surprised and happy woman, when he told her she would not have to move out—that the little house was her own.

This happy incident occurred a few years ago, and the employer told me on the day I visited his plant that his foreman, George, had paid every cent on the house and since that time has never touched a drop of liquor.

This little story proves what I have always believed; that real accident prevention work must arise in the heart of the employer if the workmen are to be won to the cause of safety.

The Heart Interest

That this splendid employer was interested heart and soul in the welfare of his employes was evident by another remark he made to me that every time he looked at his own little children at home, he thought of the children of the men who worked for him, and he did not want one of his men to meet with an accident to cause suffering to the little ones at home.

Here is a story that every employer should take to heart. If more employers tried this plan there would be fewer accidents and closer co-operation between the man at the top and the man at the bottom.

You cannot prevent accidents and make workmen safe without using personal tact. Superintendents and foremen who do not know how to use personal tact in dealing with their men are business failures. Mechanical safeguards are good, safety committees are good, safety meetings are good, safety motion pictures are good, but I say best of all is the friendly personal relation between employer and workman.

Lincoln beautifully defined this personal relation when he said, "When they lay me away, let it be said that as I traveled

along life's road I have always endeavored to pull up a thistle and plant a rose in its stead."

Adopt Lincoln's advice and put a human touch in your business relations with your employes. Pull up the thistles and try planting roses. Then watch the results.

An Accident Prevention Campaign in an Open-Hearth Steel Foundry With the Aid of Safety Committees

By F. G. Bennett, Columbus, Ohio

The plant that is being discussed is located in Ohio and consists of a foundry building 1200 feet in length with side floor leantos for molding machines. In direct connection with this building is the cleaning department running at right angles from the main foundry building. Seven 25-ton open-hearth furnaces and one 8-ton electric furnace comprise the melting equipment. Forty overhead cranes are used. There are separate buildings for pattern, mechanical, carpenter, core and other necessary departments in addition to the buildings just named. The maximum working force is 2200 employes and the average force is 1600. The nationality of the employes is divided as follows: White Americans, 50 per cent; negroes, 35 per cent, and white foreigners, 15 per cent.

During the year of 1917 our accident experience was what might be termed bad, and during the latter part of that year we decided to intensify our accident prevention work and inaugurate a safety committee organization. On Jan. 1, 1918, safety committees were appointed in each department consisting of from one to three members each. A definite schedule was drawn up for their meetings and activities. A meeting of all committees for each turn is held every two weeks and on the last Friday of each month a general meeting of all committees from both turns together with the foremen is held in the latter part of the afternoon, when an outside speaker addresses the meeting. These committees

are appointed for a term of three months and are now selected from employes promiscuously. In the beginning of this work we appointed subforemen and older employes on the committees, but have now decided that the best and most effective safety committee is selected from employes of all classes. We think it well to appoint new employes on safety committees as it instills in them a spirit of activity shortly after they are employed.

How Committee Members Are Appointed

All newly appointed members of safety committees are notified by a personal letter from the general superintendent and are each presented with a safety watch fob with an inscription reading, "Help Prevent Accidents Every Day." The natural query comes from almost all of the newly appointed committeemen as to what they are to do? We impress upon them that above all things they should spread a propaganda of carefulness among their fellow workmen. They are also instructed to carry on systematic inspections and report their findings accordingly.

We anticipated no noticeable effect from this committee plan for a few months but were agreeably surprised to see a remarkable and abrupt reduction in accidents after Jan. 1, 1918. The monthly average number of lost-time accidents during the year of 1917 was 62 and during the first six months of 1918 this was reduced to 26. This is a graphic testimonial of what safety committee work has done in our plant. During the first six months of 1917, 32,170 working hours were lost on account of accident absentees and during the first six months of 1918 this was reduced to 17,478 working hours. This latter figure is the real economic basis of this work.

There are other important standards that must be adopted and lived up to, to bring about successful accident prevention results. First, the management must be 100 per cent back of the movement. No movement of this nature can be successful unless the employes are thoroughly convinced that the company is behind them to the limit of limits. This will lead up to the second important standard which is the

enthusiastic spirit of the foremen throughout the plant. Without these two important factors no safety committee organization will succeed. Publicity through bulletin boards and shop magazines relating stories of accidents and their prevention is a necessary feature. We have also found that an occasional talk by the highest executive in the organization to the safety committees and foremen is wonderfully beneficial. In all meetings we consider it very important that some official of the company be present even though he only takes part in the discussion, as his presence indicates an interest on the part of the company. For example, at one of our meetings the president of the company was present sitting among the workmen and being no more than a listener.

A Permanent Feature

As to our opinion of safety committee work, we can only say that we have started it and it is now on a thoroughly working basis and the results we are obtaining far exceed our expectations. We have no thought of discontinuing safety committee work as we feel that it is sound enough to be a part of our operating organization. There have been some mistakes made in safety committee work on the part of companies who thought that these committees can only be composed of subforemen or employes long in the service, feeling that after having included all of these persons on safety committees the work has been accomplished. Our feeling is that the work has just been started and that the new employe must be recognized in activity of this nature. We do, however, feel that it is well to form a committee with at least one of the older employes as a member.

There has been nothing mentioned in this paper concerning the installation of mechanical safeguards as it was the purpose of the author to confine this discussion to the larger group of accidents from the lack of thought on the part of the employes. We can see no other means of attacking this large group of accidents than by systematic safety committee organization. We are convinced from our own experience that it is paying and we feel and anticipate that we will obtain better results in the coming months.

Organizing a Foundry for the Economical Production of Gray Iron Castings

By PAUL R. RAMP, Muskegon, Mich.

In organizing a foundry to produce tractor castings, the question of suitable buildings and the proper shop equipment must receive careful consideration. Equipment can be furnished today to take care of almost every operation in the foundry, and the manufacturers are in a position to exhibit the results of their labors along this line in numerous foundries throughout the country. This fact is of great value and help to us in deciding what tools will best suit our needs; and we are relieved to a great extent of the equipment problem by relying upon people who have made this part of the business their life study.

The same is true regarding the buildings. We have construction engineers who are able to design buildings that will permit us to handle our particular class of work to the best advantage. With the exception of a few suggestions and final approvals, we can be relieved of the large amount of work and study necessary to design the buildings, and at the same time be provided with a much better layout from men trained for this branch of work.

Our Fathers Worked Harder

This was not true years ago—then the foundryman was expected to be able to divide his time between designing a foundry, inventing equipment and managing a foundry. The writer's father, also his grandfather both worked harder to produce a smaller tonnage, because of this condition in their day.

In view of the fact that we can get so much help from these sources without any great amount of study on our part, I believe we should devote more of our time to the question of the efficient organization of the foundry.

Many firms spend large sums on new buildings and new equipment and wonder why they do not get the results they are entitled to. The answer is "lack of organization." They must remember that the old organization does not always fit into the new conditions.

It is a sad sight to see the old gang in the new shop doing things just like they did 40 years ago, and just like they did in the old shop. They appear to think the new shop and the new equipment is all that is necessary, but it has no value unless it is put to work.

With modern foundry buildings, good crane service, modern equipment for molding, coremaking and casting cleaning departments, good melting facilities, and a layout that will reduce the general labor to a minimum, a decided reduction in the cost of producing castings can be made, and at the same time the quality will be improved.

Tonnage Not the Whole Story

There are many foundries of this kind in operation today, and if a careful analysis of what really caused the reduction in the cost of production be made in many cases it would be found that the increase in tonnage alone was responsible. Any kind of foundry practice will produce 100 tons of castings cheaper than 40 tons per day, for the simple reason that the overhead expenses are reduced. The non-productive labor is less per ton and the material can be purchased at a more reasonable rate.

Now if the most modern foundry practice be established in a modern foundry upon the day the first metal comes from the cupola, a very different result will be obtained, and the reduction in the cost of castings resulting from the increased tonnage will be only a small percentage of the saving. The time to make a new foundry pay is the first day castings are made in it. That is the time the foundry superintendent should lay aside the hat his father wore and get

out of the old rut and insist upon his men working according to modern methods. A molder cannot produce any more molds because he is working in a new shop, if he has the same old flask, or the same old pattern he had in the old shop, and is molding it the same old way. Even if he can, it would be a hard matter to make him do it.

When the New Broom Sweeps

But if this old job is carefully gone over with a view to molding it the cheapest and safest way, and alterations made to flasks and pattern accordingly, a very gratifying increase in production can be realized, and the fact that everyone expects changes in the new shop will help to establish the daily production on the job without the usual opposition.

Every job that is started in the new shop should be handled in this manner without too much consideration as to how many there are to make. At this time it is not so much a question as to what profit can be realized, as it is a question of establishing a modern foundry practice that will result in a reduction in the cost of productive labor. With the increase in the production per molder, the nonproductive labor will drop automatically.

The foundryman must not expect his new buildings, his new equipment to have brains, or to accomplish anything out of the ordinary with them unless he provides an efficient organization.

With this in mind, I believe the most valuable phase of my subject will be, the supervision of a foundry producing tractor castings. It is just as important to devise a system of supervision that puts to work, and keeps to work, every part of a plant, as it is to build and equip the shop.

The secret of successful organization lies in getting the right men on the jobs they can do the best, and keeping them busy.

A foundry organization should consist of a foundry superintendent in general charge, a foundry foreman in charge of molders, a core room foreman in charge of coremaking, a casting foreman in charge of the casting cleaning room, and a general labor foreman in charge of all un-

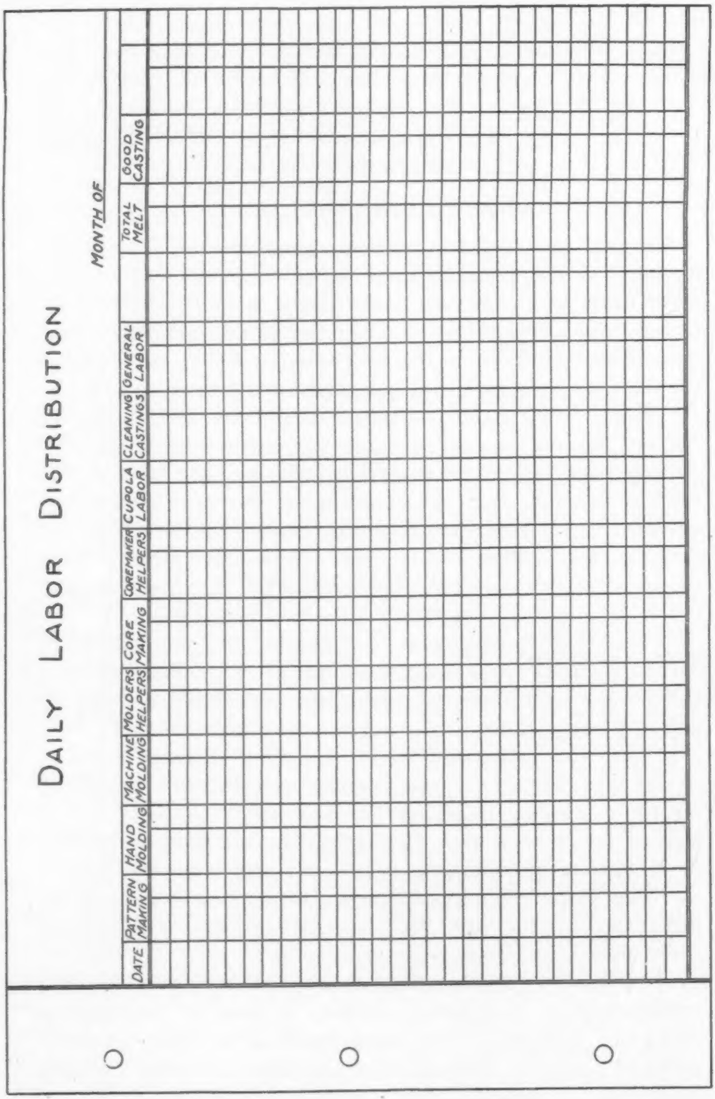


FIG 1—DAILY LABOR DISTRIBUTION RECORD TO BE PLACED IN HANDS OF FOUNDRY SUPERINTENDENT EVERY MORNING

skilled labor. A patternmaker foreman in charge of patternmakers and pattern storage, a production clerk, a cost clerk and a timekeeper also are essential.

The size of the shop will determine whether or not a man will be required to devote all of his time to one or more branches of the work.

Keeping Next to the Job

In order to create and maintain this organization and get results, the foundry superintendent must systematize his work in a manner that will keep him in close touch with the success and the failures of every department and every man in the plant.

We have proved to our entire satisfaction that with the proper information at hand daily, the foundry superintendent or manager can in less than 30 minutes know how efficient every branch of his organization is and where he is needed the most. First, he must have a daily labor distribution sheet. Fig. 1. This sheet must be posted early every morning ready for him to look over after his first trip around the shop.

This report must show the money cost of the following operations or departments of the day previous: Patternmaking, hand molding, machine molding, molders' helpers, coremaking, coremakers' helpers, cupola labor, cleaning castings, general labor, total melt, good castings per floor, and any other important items.

The weight of the "good castings per floor" should be entered not later than the second day after the heat.

News Not History

This report gives him what the monthly or weekly cost report fails to do, a chance to get quick action on expensive errors, or leaks before a heavy expense is incurred.

It is not necessary for us to go into detail regarding the value of this sheet, only say the wide awake foundry manager will very quickly detect a variation in the cost of any department with his sheet before him. He will at once find out why, and take the necessary steps to cure the evil. He will want to know why his coremaking cost $30 more

DAILY PRODUCTION RECORD

MAY SCHEDULE

Description	Transmission Case		Cylinder		Cylinder Head		Bottom Crank Case		Gear Case Cover		Piston	
Order No.	1440		1440		1440		1440		1440		1440	
Pattern No.	5004		5000		5002		5121		5122		5003	
Core No.												
Required Daily	50		50		50		50		50		200	
Total Wanted	1250		1250		1250		1250		1250		5000	
Date	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total
May 1	50	50	50	50	60	60	50	50	40	40	100	100
" 3	50	100	40	90	60	120	50	100	40	80	100	200
" 4	50	150	45	135	60	180	50	150	40	120	150	350
" 5	50	200	50	185	60	240	50	200	40	160	150	500
" 6	55	255	50	235	70	310	50	250	40	200	200	700
" 7	50	305	45	280			50	300	40	240	200	900
" 8	45	350							40	280	200	1100
" 10	45	395			65	375			40	320	200	1300
" 11	50	445			70	445			40	360	200	1500
" 12	50	495			75	520			40	400	250	1750
" 13	55	550			73	593					250	2000
" 14	50	600			75	668					250	2250
" 15	50	650			74	742					250	2500
" 17	55	705			75	817					300	2800
" 18	50	755			30	847					300	3100
" 19	50	805			70	917					300	3400
" 20	50	855			70	987					300	3700
" 21	50	905			75	1062						
" 22	45	950			70	1132						
" 24	50	1000			40	1172						
" 25	50	1050			70	1242						
" 26	50	1100			70	1312						
" 27	50	1150										
" 28	50	1200										
" 29	50	1250										
" 31												

Description	Cylinder Head Cover		Fan Bracket		Fly Wheel		Turning Gear		Valve Stem Guides		Intake Manifold	
Order No.	1440		1440		1440		1440		1440		1440	
Pattern No.	5005		5123		5124		5125		5126		5127	
Core No.												
Required Daily	50		50		50		50		200		50	
Total Wanted	1250		1250		1250		1250		5000		1250	
Date	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total
May 1					50	50	100	100	800	800	50	50
" 3					50	100	100	200	800	1600	50	100
" 4					50	150	100	300	800	2400	50	150
" 5					50	200	100	400	800	3200	50	200
" 6					50	250	100	500	800	4000		
" 7					50	300	100	600	800	4800	50	250
" 8	50	50			50	350	100	700	800	5600	60	310
" 10	50	100			50	400	100	800			60	370
" 11	50	150			50	450	100	900			60	430
" 12	50	200			50	500	100	1000			60	490
" 13	50	250	200	200	50	550	100	1100			60	550
" 14	50	300	200	400	50	600	100	1200			60	610
" 15	50	350	200	600	50	650	100	1300			60	670
" 17	75	425	200	800	50	700					60	730
" 18	75	500	200	1000	50	750					60	790
" 19	75	575	200	1200	50	800					60	850
" 20	75	650	200	1300	50	850					60	910
" 21	75	725			50	900					60	970
" 22	75	800			50	900					60	1030
" 24	100	900			50	1000					60	1090
" 25	100	1000			50	1050					60	1130
" 26	100	1100			50	1100					60	1190
" 27	100	1200			50	1150					60	1230
" 28	100	1300			50	1200					60	1290
" 29					50	1250						
" 31												

Description	Exhaust Manifold		Muffler End Front		Muffler End Rear		Governor Housing		Cam Shaft Turning Gear		Magneto Bracket	
Order No.	1440		1440		1440		1440		1440		1440	
Pattern No.	5128		5129		5130		5131		5132		5133	
Core No.												
Required Daily	50		50		50		50		50		50	
Total Wanted	1250		1250		1250		1250		1250		1250	
Date	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total
May 1	70	70	100	100			60	60				
" 3	70	140	100	200			60	120				
" 4	70	210	100	300			60	180				
" 5	70	280	100	400			60	240				
" 6	70	350	100	500			60	300				
" 7	70	420	100	600			60	360				
" 8	70	490	Man	Off			60	420				
" 10	70	560	Man	Off	100	100	No	Cores				
" 11	50	610	Man	Off	100	200	No	Cores				
" 12	70	680	Man	Off	100	300	60	480				
" 13	70	750	100	700	100	400	60	540				
" 14	70	820	100	800	100	500	60	600				
" 15	70	890	100	900	100	600	60	660	200	200		
" 17	70	960	100	1100	100	700	70	730	200	400		
" 18	No	Cores	100	1200	100	800	70	800	200	600		
" 19	70	1030	100	1300	100	900	70	870	200	800		
" 20	70	1100			100	1000	70	940	200	1000		
" 21	70	1170			100	1100	60	1000	200	1200		
" 22	70	1240			100	1200	50	1050	200	1400		
" 24	70	1310			100	1300	50	1200			400	400
" 25							50	1250			400	800
" 26											400	1200
" 27											400	1600
" 28												
" 29												
" 31												

Description	Fan Belt Pulley		Power Belt Pulley		Steering Segment		Housing End R H		Hand Hole Cover	
Order No.	1440		1440		1440		1440		1440	
Pattern No.	5134		5135		5136		5137		5138	
Core No.										
Required Daily	50		50		50		50		50	
Total Wanted	1250		1250		1250		1250		1250	
Date	Daily	Total	Daily	Total	Daily	Total	Daily	Total	Daily	Total
May 1	400	400	50	50						
" 3	400	800	50	100						
" 4	400	1200	50	150						
" 5	400	1600	50	200						
" 6			50	250						
" 7			50	300						
" 8			50	350						
" 10			50	400						
" 11			50	450						
" 12			50	500						
" 13			50	550						
" 14			50	600						
" 15			50	650						
" 17			50	700						
" 18			50	750						
" 19			50	800						
" 20			50	850						
" 21			50	900						
" 22			50	950						
" 24			50	1000						
" 25			50	1050						
" 26			50	1100						
" 27			50	1150						
" 28			50	1200						
" 29			50	1250						
" 31										

FIG. 2—DAILY PRODUCTION RECORD—THIS REPORT SHOULD BE MADE OUT IN DETAIL AND PLACED ON THE FOUNDRY SUPERINTENDENT'S DESK EVERY MORNING

yesterday than it did the day before; why the general labor has gone up $5 and why the weight per floor has dropped. The fact that he is following these things daily, rather than weekly puts every foreman he has on his mettle, and keeps him working on the job every moment.

A daily production sheet similar to the one shown in Fig. 2, keeps him informed of any delays or any work that is not started according to schedule. The plan is to look over the production sheets for the work not being done rather than for the work that has been accomplished.

As it is a quick job to locate the slow moving parts, or parts that have not been started on this sheet, it requires only a few moments to look over the entire list of orders for a very large shop, and thus the superintendent has the information that enables him to get behind the slackers before there is any outside complaint.

With orders lined up in this manner, the coreroom clerk must keep a similar sheet in the coreroom covering all parts that require cores with a separate column for each core required to make a complete set, and each set of cores in groups.

The foundry superintendent must look over his coreroom sheet while on his first trip around the shop in the morning, as it is possible to have the core production posted earlier than the general production sheet.

The same plan is carried out in the casting cleaning room, this sheet being the same as the general production sheet only showing the delivery of castings instead of molding.

The superintendent must look over the casting cleaning room sheet on his first trip around the shop also. After he has returned to the foundry office and checked up the general production sheet, he is well informed as to how the work is moving.

Not a Production Clerk

This plan does not make a production clerk out of the foundry superintendent as some may think. The writer has gone over the daily labor sheet, the daily production

DAILY FOUNDRY DEFECTIVE WORK

-----------------DEPT. DATE-------------

PATT. No.	DEFECTIVE BUT NOT REJECTED	REJECTED	WEIGHT REJECTED	NATURE OF DEFECT	WORKMAN'S NAME	WORKMAN'S EXCUSE	FORMAN'S REPORT	FOREMAN'S REMEDY

-------------------------INSPECTOR ---------------------FOREMAN

FIG. 3—DAILY FOUNDRY DEFECTIVE WORK REPORT TO BE MADE OUT BY FOREMEN

sheets and the defective records in less than half an hour and secured the information necessary from each one that enabled him to bolster up the weak places in his organization.

Every foundry has a bad casting report, as this report is absolutely necessary to the cost department. Now in organizing a foundry that is going to produce tractor castings or any other castings at a reasonable cost, and of a quality superior to the castings made by the majority of foundries, it is advisable to have in addition to the regular bad casting report, a daily foundry defective work record, as shown in Fig. 3.

This report not only gives the number of castings bad, but the number of castings defective but not lost. It is just as important to reduce the number of castings made that are not perfect but can be used, as it is to cut down the percentage of defective castings that must be scrapped. With this in mind we insist upon a daily record under the heading "Defective But Not Rejected," in addition to the regular bad work report. The manner in which the daily defective work report is handled is as follows:

The casting inspector or cleaning-room foreman furnishes each foreman who is directly in charge of a number of molders or coremakers a report on this blank daily. This report covers all the lost or defective castings or cores made by the men under the foreman.

How Report Is Filled Out

The report the foreman receives will be filled out under the following headings: Pattern Number, Defective but not Lost, the Number Rejected, Weight of Rejected, and Nature of Defect, leaving blank the space under the headings, Workman's Name, Workman's Excuse, Foreman's Report, Foreman's Remedy.

Upon receipt of this report it is the foreman's duty to immediately investigate each case reported. He must fill in the name of the workman who made the bad work. The record of the man's excuse, his report as to what he thinks is the cause of the defect and his remedy. This remedy will be what he thinks should be done to overcome the

trouble. When this report is completed, the foreman must turn it in to his superintendent or to the trouble man, if one is a part of the organization.

Some will say, "This is a lot of red tape. You are loading up the foreman with work that should be performed by a clerk." This is a mistake. The clerical part of the job can be done very easily as the foreman investigates each case.

This report is not made as a record for accounting, but is an instrument to place in the hands of the foundry superintendent to use to get prompt action out of his foremen on all defective work.

Should a foreman complain that he is too busy to do this work, we are overloading him, or he is not big enough for the job. If one foreman has so many men directly under him that he is unable to spare the time to investigate the cause of their losses, and teach them how to overcome their trouble, we can feel safe in deciding we have a weak spot in our organization that should be strengthened at once.

Trusting to Luck and the Men

This report also informs the foundry superintendent as to how a foreman is handling his men. It is surprising how many foremen there are who trust to luck and their men and get away with it. It is also surprising and very gratifying to know how much more a good man can do towards making better castings and cheaper castings if he works at the job systematically.

We have found that it is more important to try and induce the foreman to work at his part of the job steadily than the men under him, as the latter will get in line if the foreman is on the job. And this Defective Work Record was designed simply to make the foreman do the things he should do in order to give his employer the best there is in him.

In order to secure the workmen's excuse, he must visit him and talk to him about the bad work. At this time he

will naturally tell him how to avoid the loss in the future, and why his excuse is not legitimate.

In order to give the foundry superintendent an intelligent report on what he believes to be the real cause of the defect or loss (under the head of Foreman's Report) he must inspect the casting. This gets him out where we want him every morning—to the scrap pile. The fact that he is obliged to specify what he considers the remedy to cure the loss, puts his ideas in the hands of the superintendent who will be in a position to help him if he needs help.

To Eliminate Collusion

There is sometimes a connection between the cleaning room foreman or the casting inspector and the molder that tends to influence the report under the heading "Nature of Defect." For this reason we leave the entering of the man's name to the foreman in charge, and leave the cleaning room foreman in ignorance of who the molder is that made the bad or defective work. We know that some foremen will neglect this work and fill in the molder's excuse, the foreman's report and the remedy to be applied, without visiting the molder's floor or seeing the defective casting. But if the foundry superintendent is on the job, he will make it his business to regularly visit one or more molders per day and check up the excuse the report states they have given for their losses. He will also look up regularly one or more defective castings and see how the foreman's report checks with the real causes. This will always catch the foreman who is trying to get along without doing his work according to the orders he has received.

This report is very effective in creating an efficient foundry organization. It automatically tries out each foreman and puts a record in the hands of the foundry superintendent that can be compiled and used to a great advantage by him in making important changes in his supervision. Aside from this, if this system is insisted upon and continued from day to day as intended, we know from experience that the percentage of defective and bad work will decrease.

This report is not intended to be used in connection with the foundry cost system, unless the cost department can use it without any changes. It is designed for the benefit of the foundry management to enable it to handle this part of the organization with intelligence and dispatch.

Hourly Progress Report

When a new pattern is started in the molding room the foreman to whom it is given should make a special effort to secure the best production of good castings per day possible. Very often established daily production on the new job falls below the estimate because the foreman in charge does not give the man on the work enough of his personal attention.

In order to force the foreman to visit this man at least once every hour, we require of him an hourly progress report as shown in Fig. 4. He is expected to visit the new job every hour and jot down the progress made by the workman, seeing if he is up to the point in his production he should be. The foreman must find out why and help him to get up to the schedule before another hour has passed if possible.

It is better that a man be checked early in the day and brought to account for lagging, than to wait until the day is over and call his attention to his shortage. If at 9:00 a. m. he is behind he should be helped at that time and as a result his daily production will be greater than if he is allowed to go his own way until the end of the day.

This report is made on new jobs or old jobs that have been improved only. The foreman must not be allowed to have the clerk take up this report, as the idea is to get the foreman to this floor at least every hour until the production has been established. And the hourly progress report will show the foundry superintendent what progress is being made, and that the foreman is watching the job.

Weekly Improvement Record

Fig. 5, the weekly improvement record, is a blank that will work wonders if the right force is put behind it. Every

HOURLY PROGRESS REPORT

DEPT. DATE

WORKMAN'S NAME	9 A.M.	10 A.M.	11 A.M.	12 M.	2 P.M.	3 P.M.	TOTAL	PATTERN	FLASK

REMARKS

FOREMAN

FIG. 4—HOURLY PROGRESS REPORT

foreman feels that he should receive credit for any improvements he makes in his department and it is a pleasure for him to be able to turn in a report covering such progress at the end of the week, which he knows will be placed on file to his credit.

The fellow that is not ambitious but is aware of the fact that there is a weekly improvement report blank being used in the shop, feels that he must, at least occasionally, turn one in and this puts him to work trying to create something that will keep his name on the list of progressives. If each foreman turns in one substantial improvement report per

week, the organization is effective and the foundry superintendent or manager has reason to congratulate himself.

Foreman's Personal Schedule

There are many good men who would make efficient foremen if they were given more instructions on how to plan their work. The writer has developed good foremen out of men who were working themselves to death and accomplishing nothing by preparing for them a personal schedule, specifying what they should do at certain hours in the day.

For instance from 7:00 a. m. to 7:30 a. m. visit every molder and see if he has the necessary equipment or a job to start, etc. From 7:30 to 8:00 a. m. put men to work. From 8:00 to 8:30 a. m. order cores for the following day, and take up with the core boss any complaints about his cores. From 8:30 to 9:00 a. m. visit every molder's floor whether you have any business with him or not. This schedule should be made out to take care of every half hour of the day.

Coremaking

It is not the intention to make a foreman do his work according to the time laid out. In the long run this would not be practical, but this schedule is a secret between the foundry superintendent and the foreman, and the foreman quietly follows it until he has formed a habit of attending to his work systematically. He finds that he can execute the tasks specified on his schedule in one-fourth the time he has given himself, and he naturally asks himself "now what will I do to fill in the balance of the half hour?" This plan gets him around the shop driving the work instead of letting the work drive him.

In organizing a foundry it is necessary to make many foremen. They cannot all be hired, and sometimes a little help of this kind is all a man needs to make him a valuable servant for the company. The foundry superintendent

WEEKLY IMPROVEMENT RECORD

WEEK-ENDING

PATTERN	PREV. DAILY PRO.	IMP. DAILY PRO.	INCREASE IN PRO.

DESCRIPTION OF IMPROVEMENT

FOREMAN

FIG. 5—WEEKLY IMPROVEMENT RECORD

should be familiar with his foreman's duties so he can outline a schedule of this kind when it is necessary.

Coremaking Problems

The coremaking connected with the production of gray iron castings plays a very important part in their quality and cost. The core department should be laid out in such a manner as to permit of the cores being made in one room and assembled in another. The two departments can be separated by locating the drying ovens between them with doors at both ends of the ovens, one set of doors to open on the coremaking side and the other set of doors on the assembly side. This plan will allow the coremakers to load the oven trucks in their room and place them in the ovens; it will also allow the assemblers to unload the

trucks in the assembling department without interfering in any way with the coremakers.

By separating the coremaking from the assembling we automatically create a core inspection department among the assemblers.

When a coremaker assembles the cores he makes he will naturally cover up any defects he discovers that are the result of his carelessness and by this act very often causes the molder to produce a defective casting.

When the coremaker's work is assembled by another workman who is obliged to put his mark on every set of cores he assembles, he does not hesitate to report unreasonable defects in order to escape having his work condemned. The same is true where cores are blacked and joined by the assembling department.

Aside from this very great advantage of having the additional check on the coremaking, we have found that better work and more work can be done by dividing the department in this manner.

The coreroom should be laid out with a view to locating the sand-mixing and sand-reclaiming equipment in the most convenient place for obtaining new material and for delivering mixed sand to coremakers.

How to Prepare Oil for Sand

In mixing oil sand we have found that a better core can be produced with less oil by preparing the oil before adding it to the sand as follows:

Fill a tank or barrel three-quarters full of water and oil, one-third to be oil and two-thirds to be water. Run a high pressure air line into the tank within six inches of the bottom. A short time before the liquid is to be used turn on the air pressure and allow it to blow through the mixture until the tank is filled with foam. This will be an indication that the oil and water have been thoroughly mixed. The foam will settle in a short time when the correct quantity of the mixture can be added to the sand. The sand mixer man must remember that only one-third of the liquid is oil.

and make his additions accordingly. This plan enables us to reduce the percentage of oil required to make good cores very materially. The oil when mixed well with the water can be distributed through the sand more thoroughly.

In testing oils we have found that the oil that produces the strongest core does not always produce the soundest casting, and the strongest core does not always stand up the best when surrounded by hot metal. For this reason we do not recommend making any decision on the oil to be adopted as our standard until the binder has been tested as to the percentage required to make a firm core that will stand up with the hot metal around it with the least rodding and the least venting. In making these oil tests, we have found that all of the oils are improved by mixing with water by air pressure.

The most effective way to handle the core orders is direct from the foundry office to the core department, having the foundry production man issue these orders. The coreroom clerk should also be the coreroom timekeeper, and he should keep the coreroom production sheet.

Don't Make Useless Cores

A great deal of money is often spent in producing cores that are not used and remain in storage so long that they become worthless. Also production is often held up because of the complete sets of cores are not made as required to keep the work flowing through the shop. Both of these troubles can be overcome by the use of the daily production sheet shown in Fig. 2.

Where a number of cores of different sizes and shapes are required to make one complete set, we have found it advisable to number the various cores from No. 1 to the number equalling the number of cores in the set. Wherever possible this number should be put on the box where it will show on the core. This helps the production record, and makes it easy to make separate piecework prices. Also it helps to identify the core for inspection and delivery.

The delivery of cores costs more than we sometimes realize. By the use of electric trucks it is possible to re-

duce this cost 50 per cent. In order to use the trucks the gangways must be kept clean and smooth all through the shop and special core racks should be made to take care of a large number of small cores. These racks should be provided with shelves that will accommodate the core trays.

The assemblers should load these racks with the cores that are to be used by a number of molders working in one part of the shop within a few yards of each other. The electric truck picks up the rack and takes it to a point where it will be most convenient for all of the molders whose cores are on it. Large cores, such as transmission case and crank case cores, or assembled cylinder cores should be placed in special cradles. These cradles are loaded onto the skids and the skid carried to the molder's floor by the truck. Where a large floor is using a great many cores a special rack should be provided to take care of enough small core trays to enable the core department to deliver a separate tray of cores for each mold. This plan helps the molders very much and prevents excessive breakage. In order to avoid confusion each molding floor should be numbered.

Organizing a Girls' Core Room

The organization of a girls' coreroom should receive very careful study in order to secure maximum production. This department is too often limited to small cores because they are light and can be handled by girls. This is a mistake. A system of having the cores carried to the ovens, and the dryers and plates to the workers by men will relieve the girls of the heavy lifts, except in cases where the coreboxes and plates are too heavy for them to roll-over and draw. This is taken care of in cases where the cores are very large by the use of a roll-over molding machine that will roll-over and draw the box. However, there are a large number of cores that are too small for the molding machine and too large and heavy for the girl to roll-over and draw continuously. For this work we have discovered a very effective core drawing machine now on the market that takes care of all of this intermediate work, and adds to the

number of cores that can successfully be produced by girls or green men fully 100 per cent.

With this machine it requires no skill to successfully draw a corebox from the most delicate core. The machines are portable and can be moved to any bench where the operator has difficult or comparatively heavy work to make. In producing cores that must be perfect and free from tool patches, variations in size, etc., also cores wanted in large quantities, this machine simplifies the work and makes it possible for women or new beginners to do it satisfactorily.

Women will work more steadily than men. While they will require more supervision and more attention in the way of help in lifting, etc., they become very proficient. They are a decided success in the production of cores for tractor or other similar castings. As assemblers we find them in many cases superior to men. The utmost care must be exercised in selecting the forelady. She should be a disciplinarian rather than a good coremaker.

Core Department Rules

In creating a coreroom organization, we have found it very helpful to establish a few rules for this department and insist upon their being observed at all times. Some of them are as follows:

1.—Core assembling department must unload all core-oven cars, and return all core-plates and core-dryers to the coremaking department.

2.—Rod and wire cutting or straightening must not be be done by coremakers.

3.—Coremakers will be paid for cores accepted by the oven-man only, who will provide each coremaker with core checks as he receives the cores on the receiving bench in good condition.

4.—Cores rejected on account of improper venting will not be paid for whether or not they have been accepted at the oven.

5.—Core assembly piecework cards must be signed by the inspector.

6.—Cores must not be delivered to the molder's floor if he is absent, or if he is not going to use them the day they are delivered.

7.—Coremakers will not receive credit for an over-production of more than 10 per cent of the number called for on the daily schedule.

8.—Sand mixers must demand a sand ticket for every load of sand they deliver to the coremakers. Coremakers will be provided

with a sufficient number of sand tickets to produce their work by the foreman. Sand mixers must turn in all tickets they receive daily with their piecework slip to enable the timekeeper to check the work.

Molding Machine Hints

In selecting molding machines it is advisable to consider the following. A simple machine plus brains equals more than a complicated machine. A machine is often installed by the alluring statement that it rams the mold, rolls it over, draws the pattern, and does a great many other things automatically.

There are very few cases on record where a molding machine regardless of the make did satisfactory work the first few days it was started. It takes more time and more study to get a molding machine job started properly than it does to start an ordinary floor or bench job. Molding machines will not eliminate all the foundrymen's troubles. They do not help, but become a detriment if we forget to use brains behind them.

The usual objections to the installation of molding machines are as follows: We have not enough work of the same pattern to use machines. Or, we have tried machines and found we do not need them because our men make just as many molds on the bench or floor as they did on the machines.

To the first objection we will say, a machine properly directed can have the patterns changed on it a dozen times a day and be a paying investment. For instance, compare the bench-molder with his two rammers, with a molder with a hand squeezer, or draw a comparison between the molder with the hand squeezer and the molder with the power squeezer. The molder with his two rammers must pound against the hand squeezer where all that is required is one pull of the ramming lever. The man operating the hand squeezer must pull his lever against the simple turning of the valve handle, which gives the power squeezer man a great advantage over him.

Consider the wide difference between the molder with his two hand rammers and the operator with his valve handle in actual labor required, and I know that you will

agree that the foundryman who is content to have his men demonstrate to him that they can produce as much work by hand as with a machine is being misled. Very probably machine production has been intentionally slowed down in order to make a comparison that will defeat the installation of machines in the foundry.

Molding Machine Facts

If the molders are making 100 molds hand work, it is safe to say they can make 200 with the hand squeezer. If they are making 200 molds with the hand squeezer they can make 250 or 275 with the power squeezer.

'Tis true there are a few jobs that can be made more successfully on the bench or floor with hand rammers, but the number that cannot be worked on the machine at a decided saving is generally much less than reported by the man in charge, who does not care to use his brains to develop the molding machine in his work. The most effective plan in installing machines in a foundry where the foreman is not very enthusiastic, is to employ a molding machine expert for a period to supervise the selection and fitting up of all patterns, and to establishing production on the machines.

A Corliss engine-bed weighing 15 tons can be rammed on a jolt machine in a moment. The same work done by hand would require one day's work for two molders and two helpers.

Where a large number of machines are used, there should be a number of emergency machines that are operated only when one of the regular machines is down for repairs. This avoids delays and cuts in the production.

When Pouring Off

The molds required to produce 100 to 125 tons of small castings cover considerable floor space unless a plan of continuous pouring is established. This cannot always be done.

In order to avoid cutting down the molding time and to do away with the old scheme of things where every molder stops molding when the blast goes on, a very effective plan is to pour

off in sections. Lay the shop out in sections, each section to cover the number of floors required to take care of the metal as fast as it is melted with the exception of probably a few floors that must have first iron every night. Assuming that the shop is large enough to divide it into five sections, the operations would be as follows:

All molders working in section No. 1 will begin pouring as soon as the iron is down. When section No. 1 is poured off the men in No. 2 will receive their iron. Sections Nos. 3, 4 and 5 follow according to their numbers. On the second day of the week section No. 2 gets the first iron with sections Nos. 3, 4 and 5 and No. 1 following; on the third day section No. 3 pours first and section No. 2 is last.

The section pouring the first iron is the only one that should be allowed to stop molding when the first iron comes down. Their production will be less than the sections that follow them, but on the next day they are the last to receive iron and will have the greatest production. This plan increases the daily output per man and keeps the men satisfied. It is an important thing that the men in the section pouring first be allowed to go home just as soon as they have poured off. This acts as an incentive and induces them to enter into the scheme readily.

This plan has many advantages over the usual plan of trying to give every part of the shop iron at the same time. The men are not heated up so long, the ladles do not get cold between deliveries to their floor; the night men are able to start quicker with their work without interfering with the molders, and the production is greater. The molders get so they plan their little amusements to take place on the night they know they are to get first iron.

We have found the overhead trolley the most effective method for delivering iron to the floors for this class of work.

Paying for Pouring on the Piecerate Basis

A piecework system for delivering the metal is very valuable. The cupola man at each cupola is provided with ladle checks, and as each man leaves the cupola with a trolley ladle full of metal for some part of the shop, the cupola man presents him with one of the checks. The ladle man later turns his checks

into the timekeeper, who gives him credit at the price per ladle agreed upon. With ladle men working piecework there is no trouble experienced in getting the ladles back to the cupola in time. In fact these men continually urge the molders to hurry with the pouring so they can get back and get another check. With this plan a part of the organization the number of ladle men required to deliver the iron is reduced 50 per cent.

Some Cleaning Room Stunts

The cleaning department should be planned to allow the rough castings to be delivered to the tumbling mills and from the mills to the chipping benches without any hauling, and similarly from the chipping benches to the grinders and from the grinders to the delivery trucks or conveyors.

Every tumbler should be a complete unit in order to keep it working all the time. The best plan is to arrange a row of tumblers in line with the loading side opposite from the unloading side. The rough castings from foundry should come in on the loading side and the chipping benches should be located about 36 inches from the mills on the unloading side.

The mill men should handle their work as follows: Load mill No. 1 and start it. Then load Nos. 2, 3, 4, 5 and 6, starting each one as soon as it is loaded. If a careful study is made of the work before the number of mills two men can take care of is decided upon, the first mill will be ready for unloading by the time the last mill is started. As soon as the first mill is unloaded it must be reloaded and started before mill No. 2 is unloaded. Mill No. 2 must be unloaded and started before mill No. 3 is unloaded and so on all the way down the line. This plan keeps the mill men busy and allows only one mill to be idle at one time. This always reduces the number of mills required to do the work 100 per cent under the old method of starting them together and stopping them together, as in cases where a battery of mills are driven with one shaft.

The plan of unloading the mills directly onto the chipping benches provides a good check on how fast the chippers are handling the work. If the benches are loaded full of tumbled castings, it is an indication that the chippers are lagging or there are not enough men on the job. If the benches are empty it is

evidence that the mill men are too slow or have too many mills to take care of.

The same plan can be applied to the sand-blasts. We will not go into detail regarding this department only to say we have found after a great many experiments that a decided saving is effected in the cleaning room by making a careful study of the quality of the plumbago and core wash used in producing the larger molds.

We have found in core washes it is not always the article that sells at the highest price that saves the most money, neither is it the cheapest wash. A daily check on the appearance of the castings and the length of time they were milled very soon tells what kind of material to use and how to apply it.

Pattern Shop Suggestions

Having the patternmaker foreman report to the foundry superintendent does away with the old-time habit of the foundry blaming the patterns for a portion of its losses and delays. It has always been conceded that the foundry superintendent and the pattern foreman should work together, but we have found that better results are obtained when the pattern foreman is working under the supervision of the foundry superintendent. This plan puts the production up to the foundry with no excuse for mistakes, and it has been demonstrated that the patterns come out to the foundry more promptly and are constructed in a manner that makes molding more simple.

The drawings and orders for new or altered patterns are received by the foundry superintendent who specifies how he wants to mold them before turning them over to the patternmaker foreman. When the pattern foreman receives an order for patterns, he estimates the number of hours required to make the pattern, entering the same on his "Hours Required" report. When the pattern is completed he enters the actual time consumed on the same record opposite his estimate and he and the foundry superintendent note the difference between the estimated time and the actual time. It is only natural that the patternmaker will try to do better than his estimate.

This plan enables the foundry superintendent to know just how his work stands in the pattern shop. He knows how many

hours of pattern labor he has ahead of him and how long it will take him to get it done. It also gives him a chance to check up his foreman's ideas of the time he intends to put on a pattern and should it be unreasonable he has an opportunity to make changes to shorten the time before money has been wasted in unnecessary labor and material.

Not Limited to Large Shops

An organization of this kind is not limited to a large foundry. The manager who has a small foundry in connection with his plant can take over the duties outlined for the foundry superintendent and do some very effective work even though he is not a practical foundryman.

In large shops producing 90 to 150 tons of good castings daily, the plan is ideal as it is in a question of the supervision of a number of foundries operating under one foundry head.

The thought I want to leave with you is this: The organizing of a gray iron foundry means producing an organization that will work together nine hours per day and that realizes that the key to successful organization is quick action.

The machine to get working right, to inspect daily, to keep in repair, to keep well lubricated, is the machine that is composed of the foundry superintendent, the molding room foreman, the core boss, the pattern foreman and every other fellow who has anything to do with the supervision of the work going through the shop.

Report of Committee on General Specifications for Gray Iron Castings

Your committee begs to report progress for the year just closed. The extraordinary industrial conditions existing in the country at the present time have precluded any possibility of getting together on the part of the committee, and what has been accomplished has had to be by correspondence entirely. In co-operation with the American Society for Testing Materials the work of preparing specifications for molding sand has been taken up, as has also a study of proper definitions for foundry terms.

While, therefore, some progress has been made, the work of the committee has to adjust itself to the opportunity of its members, and for the moment, this really means marking time. The committee, therefore, respectfully asks that it be continued and hopes to achieve a more rapid advance as soon as the industrial conditions of the country may allow it.

The subcommittee on specifications for steam and hydraulic castings has prepared proposed standard specifications under the direction of its chairman, R. S. MacPherran, Allis-Chalmers Mfg. Co., Milwaukee. These specifications are as follows:

PROPOSED TENTATIVE SPECIFICATIONS FOR STEAM AND HYDRAULIC CASTINGS

1.—Unless furnace iron is specified, the cupola process is understood.

2.—The sulphur content shall not exceed 0.12 per cent.

3.—Castings shall be divided into those of medium and heavy pressure. Castings with a maximum working pressure of 100 pounds

shall be classed as *medium* pressure and those of over 100 pounds shall be classed as *heavy* pressure.

4.—Transverse Test—The minimum breaking strength of the "Arbitration Bar" under transverse load shall not be less than:

Medium pressure, pounds	3200
Heavy pressure, pounds	3500

In no case shall the deflection be less than 0.12-inch.

5.—Tension Test—Where specified this shall not run less than:

Medium pressure, pounds per square inch	24,000
Heavy pressure, pounds per square inch	27,000

When called for the tension test may be made on a bar turned up from a broken piece of the transverse test.

6.—Two test bars shall be cast daily from each mixture of iron used and shall fairly represent the castings made on that day.

NOTE.—It is not at present possible to set definite limits for the chemical analysis. The following will roughly cover the majority of cases. The figures given, however, are not to be considered as mandatory, except for sulphur:

	Per cent
Carbon	3.00 to 3.50
Silicon	1.00 to 1.50
Phosphorus	0.20 to 0.60
Sulphur	Not over 0.12

RICHARD MOLDENKE, *Chairman.*

Discussion

MR. D. W. SOWERS.—We notice it is specified that sulphur should not exceed 0.12 per cent. Also there is a note on page 3 stating that it is not possible to set definite limits for chemical analysis; that the figures are not to be considered mandatory, except for sulphur.

We have been making successful castings used entirely in connection with hydrostatic work, for the last eight or ten years, the analysis of which varies considerably from the analysis set forth by Chairman Moldenke. The sulphur in our practice runs 0.16 to 0.18 per cent, while the silicon is up and the phosphorus always around 0.16 to 0.18 per cent. The tensile

strength of this metal runs from 40,000 to 42,000 pounds per square inch, and I have seen bars break even higher.

I do not believe it is practicable to make rigid specifications covering gray iron castings, including the analysis and foundry practice, on account of local conditions and methods of manufacture.

MR. R. S. MACPHERRAN.—The recommendation of 0.12 per cent sulphur limit was made merely to conform to the existing A. S. T. M. specification for gray iron castings. Personally, I would be willing to put the sulphur into the suggested analysis and not make it mandatory at all. I also believe that we should put an additional classification into this report to cover castings which are machined and subject to wear on the machined surfaces. This would include steam cylinders, liners, etc. I do not believe that the figures given in the report would result in a material always satisfactory for this purpose. I intend to suggest to the committee that we put in a classification covering these castings and make the minimum transverse load 3800 pounds and the minimum tensile strength 30,000 pounds. You will note the distinction between a machined surface subject to wear and an unmachined surface such as a chamber, pipe, steam chest, etc., where the skin of the casting is not broken nor the grain subject to any abrasive action. In the former case the metal must be harder and closer grained. I am inclined to agree with Mr. Sowers' statement that no complete chemical analysis should be made mandatory. The suggested analysis given under the note was merely to be of possible assistance to the smaller foundries working without chemical supervision and not at all intended to cover all possible analyses.

The Continuous Two-Story Foundry

By J. F. Ervin, Flint, Mich.

To convey a vivid understanding of the methods followed in a foundry devoted to the production of castings such as are used in the modern gas engine, I propose to present a general outline of the material handling operations which are necessary if the foundry is to be an economical producer. We shall consider four basic materials, namely, iron, molding sand, core sand and refuse.

Fundamentally we can safely say that the ratio of good castings to the total melt on this class of work ranges very close to 60 per cent. The ratio of the molding sand which must be handled to the metal poured, is five to one. Of this molding sand, approximately 240 pounds must be added to the heap in the form of new material for each ton of iron melted. Of core sand, the ratio between the sand and the tonnage of good castings is approximately four to five. Refuse material consisting of largely refuse core and molding sand, has a ratio of one to one of good castings.

Twenty-two Tons of Iron Handled Per Ton of Castings

Let us first consider the iron. In order to put the iron through the cycle of operations it is first necessary to unload it from the car. It must then be successively (2) transported to the charging platform, (3) charged to the furnace, (4) transported to the molding floor, (5) transported from the ladle to the floor, and poured. (6) The iron is now in the form of a casting, and must be removed from the mold to a truck. (7) From the truck it is taken to the knockout platform; (8) from the knockout platform to the sandblast; (9) from the sandblast to the tumbling mill; (10) from the tumbling mill to the emery wheel; (11) from the emery wheel to the chipping bench; (12) from the chipping bench

to inspection; and (13) from the inspection to the car. This makes a total of thirteen basic operations in handling the iron.

From these data we see that it is necessary to melt 3400 pounds of iron to produce one ton of good castings, and it is therefore necessary to handle 3400 pounds of iron in the form of raw pig, molten iron, molded castings, gates and sprues, etc., 13 times. This is the equivalent of 22 tons of material to be handled for each ton of castings produced.

Now consider the molding sand. New sand must be handled from the car to stores and from stores to heap, 240 pounds of sand being necessary for each ton of iron melted. This is, therefore, equivalent to 400 pounds for each ton of castings produced. Two handlings make a total of 800 pounds of material to be handled per ton of castings.

Since the sand is now in the heap, the next operation is the handling from the heap to the mold. Handling the mold from the bench or machine to the floor, knocking out the sand into the heap, and cutting over the heap follow in the order named. Since we have 3400 pounds of iron to handle per ton of good castings produced, it is necessary to use five times as much sand as iron melted, or a total of 17,000 pounds for each ton of castings must be handled through each operation. The four operations give us a total of 68,000 pounds. Add the necessary handling of new sand which must be introduced into the heap and we have a total of 70,000 pounds, or 35 tons.

Handling Core Sand

Core sand must be handled from the car to the yard as the first operation. Next it must be taken (2) from the yard to the inside storage, (3) from the inside storage to the mixer, (4) from the mixer to the core bench, (5) handled on the bench during the process of core making, (6) handled to the core oven, (7) from the core oven to the finishing bench, (8) handled in the finishing operations, (9) handled in the inspection operation, (10) transported to the foundry, and (11) placed in the mold.

This above shows that we have a total of 11 operations based on a ratio of 1600 pounds of material for each ton of castings produced, giving a result of 17,600 pounds of material to be handled or approximately nine tons.

The next item of considerable importance in connection with the handling of materials is refuse. All the core sand introduced into the cycle must be removed. A certain percentage of the molding sand which is burned out in the course of the work must likewise be removed. The practice generally observed results in this quantity being very nearly one ton to each ton of castings produced. This material must be loaded into satisfactory carriers, transported to the yard and disposed of by some satisfactory means, giving three main basic operations in connection with the foundry. Hence a total of 6000 pounds must be handled per ton of castings.

A Ratio of Sixty-four to One

Altogether we have to handle 64 tons of material for each ton of castings produced. These figures do not take into account the numerous small articles which are necessary, neither do they take into account the flasks, bottomboards and other manufacturing equipment.

To do this work efficiently, numerous mechanical developments, both along the line of machine and building equipment have been introduced and operated with more or less satisfaction. The existing labor shortage has prompted a great many manufacturers to resort to expensive mechanical installations in order to obtain more production from each man on the pay roll. The increased cost of labor has had a great influence on the development of such equipment.

In designing a foundry one of the items which must be taken into consideration is the cost of land. High land values have made it quite profitable for manufacturers of various products to resort to multiple story buildings. In most cases up to the present time foundries have been operated in one-story buildings. The high cost of land, coupled with many suggestions by engineers and others looking toward a solution for some of the difficulties of material handling, has in the course of the last few years developed the two-story foundry.

Purpose of the Two-Story Foundry

The purpose of the multi-story foundry is to obtain a continuous flow of product. The fact that the molder is the initial producer makes it of vital importance that he be kept

in continuous operation throughout the direct working hours of the plant. In order to do this, he must either be allowed sufficient space to take an entire day's work, and the molds must be poured by a separate crew, or satisfactory equipment must be installed to handle the sand and the molds away from his center of operation, in order to allow him to keep in continuous production.

Some manufacturers have accepted the first method and have been quite successful. This method calls for a very small expenditure for mechanical equipment. It only requires more productive equipment such as flasks, etc. Quite a number of attempts have been made to solve the question along the lines of the second plan. Those who have had large tonnages to make off the same pattern, or patterns very similar, where the flask equipment was nearly the same size, and where the class of castings could be handled through the same processes without danger of breakage have been quite successful in the installation of the semiautomatic classes of equipment, resulting in the intensive production and practically progressive manufacture which has been so successful in machine and assembly shops. The fact that they are able to specialize the employe's efforts and concentrate his work on a few simple operations, allows them to use the unskilled laborer to very good advantage to replace a more highly specialized mechanic.

The cost of the multistory building is generally conceded by most architects and engineers to be more economical for the same output than the one-story type, both foundries being operated on a continuous basis. They also have a number of other advantages. First, less floor space makes it easier to keep the building in a sanitary condition; also it is more easily ventilated, more easily heated, and more economically lighted. Last but not least, the greatest advantage of the continuously operating multistory foundry is the fact that it may be kept, in continuous operation, producing castings throughout a 24-hour day, which is three times as long as the ordinary foundry, operating under the noncontinuous methods, can be kept in production.

The types of continuous foundries which have been developed can be based on the methods of handling materials. In

what I call type No. 1, the sand is handled and conditioned mechanically, and molds are conveyed to the furnace for pouring. In type No. 2, the sand is handled and conditioned and the molds set on the floor space, similar to the ordinary practice, while the iron is transported to the molding floor for pouring.

Type No. 1 has its best application where the class of work is practically uniform. Type No. 2 has a much broader application, and can be used on almost any class of light work. Variations from these types occur largely in the method of handling the sand, molds, iron and castings. It is conceded by most engineers, and I think by all foundrymen with experience in the operation of a plant with mechanical sand-handling equipment, that the cost of handling and conditioning the sand is greater where the sand is removed from the floor, conditioned and returned to the molders, than where the sand is conditioned on the floor. It is also generally agreed that sand in most cases is not in as good condition after being handled mechanically as it is when allowed to remain on the floor for a sufficient length of time to give it the benefit of a thorough soaking.

The plants with which the writer has been connected, and also those which he has observed, have as a rule experienced more or less difficulty with the proper conditioning of their sand. The shop operated for the General Motors Corp. at the Buick plant in Flint, Mich., is run on the continuous method. The iron is transported from the cupola to the molding floor. The molds are set on the floor and poured from hand ladles. The molds are shaken out on the molding floor, and the sand passes through a grating to the floor below, where it is allowed to temper in a heap similar to that in any sand heap in an ordinary foundry. It is next picked up by a grab bucket and transported to the sides of the building where it passes through a rotary screen, and is elevated to a hopper in the roof. From this hopper, it is delivered into a drop-bottom monorail conveyor which runs over the tops of the sand hoppers at the molding machines. These sand hoppers have open bottoms from which the sand is shoveled into the molds.

Fig. 1 shows the grab-bucket standing on the monorail over the sand hoppers which receive the sand before it passes

FIG. 1—GRAB BUCKET ON MONORAIL OVER SAND HOPPERS

through the bottom riddles into the pit which delivers it to the elevator leg that in turn conveys it to the sand hoppers in the roof. Fig. 2 shows the monorail drop-bottom conveyor in operation over one of the molding sand bins at a molding machine station. These bins are 36 inches in diameter, with an open bottom which places the sand in a handy position for the operator. In this particular layout, we have all of the advantages of conditioning the sand which are had in the ordinary foundry. The sand is kept in good condition at all times.

The continuous operation of all units which enter into the cycle are imperative for the successful operation of such an institution. Gravity is taken advantage of by dropping the hot sand through a grating and the castings at the same time are removed to the first floor by being shot down an inclined chute. This inclined chute acts as a reservoir which allows the castings to become cooled to such a condition that they can be handled by hand or other satisfactory means to a truck, and thence are transported to the cleaning room.

The factory is kept in continuous operation for a period of 10 hours. The cupolas are started as soon as the molders enter in the morning, and the bottom is dropped when the molders leave.

To assure continuous production through all the operating cycles it is necessary to balance individual operations with a limited amount of material in process. In the writer's opinion, it is much more economical to carry ample stock at all times than to run the risk of hampering any of the productive operations which act on the final output of the plant. To gain this point, the design of any material handling system requires a factor of safety. This factor of safety should be in the form of accessible storage.

The building construction which has been generally accepted as the most satisfactory has been the reinforced concrete, steel and glass type. The natural tendency has been to locate the initial operation on the upper floor and to use the basement, or grade floor, for later or finishing operations. This tendency as a result has forced the prime operations such as molding and coremaking onto the second floor which is subjected to more or less vibration caused by the handling operations neces-

FIG. 2—MONORAIL EQUIPPED WITH DROP-BOTTOM CONVEYOR USED TO DISTRIBUTE SAND TO MOLDERS' STATIONS

sary in the foundry. The lack of sufficient foundation for these operations limits the use of jarring machines. This is an item for serious consideration, since the jarring machine is conceded to be most efficient for rapid and accurate production. This objection can be overcome to some extent by framing the floor to allow heavy foundations to be built from the grade. This, too, has its objections, due to the constricted area in which machinery must be located. In blocking out a foundry floor, with certain definite spaces for location of molding machinery, sufficient space must be allowed to operate the particular job, which in a great many cases is too much for another job which must be handled in the same plant. This type of construction is also expensive, and absorbs considerable of the area on the grade floor. Any machinery such as blowers, shafting, or other power apparatus suspended from the ceiling on the grade floor, causes vibrations which result in distortion of delicate green sand cores, and many molds are caused to drop unless additional precautions are taken in each of these individual cases.

No thorough engineer will make a machinery layout for a machine shop or other manufacturing plant without full consideration of the detailed operations in connection with the individual jobs to be manufactured. The variety of specific operations in the production of castings, although the castings may be of the same general type, is so great that they can best be handled by designing machinery and equipment for the individual pattern.

Ample floor space to permit individual, progressive production should be allowed and provision should be made for castings to be poured in a so-called continuous way, which in reality in most cases is in short intermittent periods.

The writer's experience with prime operations on other than the grade floor has convinced him that the possibility of economy is balanced by the added maintenance and operating difficulties. Equal attention should be paid to every material handling operation if the plant is to be run with the greatest economy.

Recent Developments in Burning Oil in Cupolas

By JOHN HOWE HALL, High Bridge, N. J.

This paper is intended to be no more than a brief report of progress with the use of the Stoughton oil burning process as applied to two cupolas used at the Taylor-Wharton Iron & Steel Co.'s plant at High Bridge, N. J., to melt iron for a 3-ton converter.

The metal melted in these cupolas, which are used on alternate days, is run into a receiving ladle on a platform scale and carefully weighed before being put into the converter. As it is not very easy to change the receiving ladles which are of a special design and are mounted on trunnions with an arrangement for attaching to a gear and hand wheel for rotating them, it is essential that the metal from the cupolas be hot enough so that the receiving ladle is not heavily sculled in the course of a day's run, which will average from 15 to 25 blows or slightly over. The converter runs on a schedule of three blows per hour, and as far as possible the entire amount of metal for one blow is accumulated in the bed of the cupola before tapping.

The cupolas themselves are lined to about 42-inch diameter at the bed and the 4 tuyeres are about 30 inches above the bottom. The tuyeres now used are 3½ inches high and 15 inches wide and are made up of brick, which demands the use of a brick tile to form the top of the tuyeres.

At the present time, when we are averaging 16 or 17 blows a day, this brick tile frequently lasts two days and sometimes three. Some months ago when we were averaging from 20 to 26 blows in a day it was necessary to replace

the brick tiles on three and generally four tuyeres every morning.

Above the tuyeres the lining of the cupola is made up of a bosh brick, which is so shaped that the cupola is boshed 3 inches on a side at a point 27 inches above the tuyeres. From this point the lining goes up approximately straight.

Oil and Air Supply

The arrangements for furnishing oil and air to these cupolas is comparatively simple. The cupolas are provided with a bustle pipe of circular cross section entirely separate from the cupola shell. From this bustle pipe 4 short down-comers are brought, each of which branches into two blast pipes which enter one on each side of a square wind box lined with brick. The two pipes enter at an angle of about 45 degrees so that the entering blast is directed approximately toward the center of the tuyere opening.

These pipes carry the main supply of air, which is furnished by a fan at a maximum pressure of about 10 ounces under ordinary conditions. A Clark blast meter is attached to the main air line, and we usually keep the supply of air at about 3800 to 4200 cubic feet per minute. The four burners are a modified type of Hauck burner and are arranged so that they can be moved backward and forward in the tuyere opening to secure the best combustion. The oil and air are fed to the burner through two pipes which pass through a small opening in the cast iron cover-plate of the wind box. The cover plate has two small peep-hole openings, and an opening at the bottom to drain out any slag in case the cupola is not tapped in time and slag is run into the wind boxes.

The oil is fed to the burners at about 45 pounds pressure and is atomized by compressed air at about 90 pounds. The oil used is an ordinary fuel oil furnished by the Standard Oil Co. and our figures on it indicate a specific gravity running from 850 to 870, a flash point from 180 to 240 degrees Fahr., a fire point of from 200 to 250 degrees Fahr. and a heat value of about 130,000 to 150,000 B. t. u. per gallon.

When we first installed this process we were making from 10 to 14 heats of carbon steel per day, which were made at the beginning of the run and this was followed up with metal for manganese steel heats. At the present time we are making rather fewer heats for carbon steel and we generally put these heats in between other heats used for manganese steel.

Reduction in Sulphur

When we first started using oil we tried many coke ratios and many different rates of feeding the oil to the cupola. As our chief object in using the process was to cut down the sulphur in our steel we were only incidentally interested in the saving of coke. We found that we could reduce our sulphur without great difficulty about one or two points, that is, if we were using coke and making steel that ran 0.08 per cent sulphur, we could get steel of 0.06 per cent sulphur or a little over with the oil. Possibly by cutting down the coke and increasing the quantity of oil burned it would be possible to better this figure, but we found when we did this that the rate of melting in the cupola was increased so much that the converter and the foundry could not handle the metal fast enough and the resulting delays gave us trouble with the metal in the receiver.

We have used so many grades of pig iron, scrap and coke since we started the oil last February that it is virtually impossible for us to give hard and fast figures for the difference which the oil has made in the sulphur content of our steel and in the handling of the cupola. We hope very much that before another meeting of the society we shall again make a great deal of ordinary carbon steel and that the specifications we have to meet will be such that we can make an exact comparison between running the cupola with coke and running it with oil, all other conditions being identical. For the present it is enough to say that with coke running 1 per cent sulphur and pig iron and scrap below 0.035 per cent in sulphur we are now turning out steel running from 0.045 to 0.065 per cent in sulphur. For these heats we use a 12 to 1 coke ratio and burn about 60 gallons of oil

per hour, and the iron melted will run from the cupola at about 1.5 per cent silicon and about 1 per cent manganese. The charges consist at the present time of 1900 pounds of pig iron and 1350 pounds of scrap, of which approximately one-third is manganese steel scrap.

Tuyeres Kept Clear

Before we installed the oil on these cupolas they were provided with four tuyeres each 4 x 10 inches in cross section. When melting with coke alone and using a metal of the composition indicated above, we had a great deal of difficulty with slag and metal getting into the tuyeres, especially if we made more than 16 or 18 blows a day. When this happened the cupola tenders had a very severe job keeping the tuyeres open with bars and sledges and the cupola, of course, ran very slowly and badly. In our particular case the use of the oil has been of very considerable advantage from this point of view, as the hot flame of the oil burner keeps the tuyeres sufficiently hot so that almost no poking is required to keep them perfectly clear.

The writer recognizes that the cupolas are of rather old fashioned design and that in some respects their performance may be very considerably improved upon, judging by what he has seen in foundries using the Tropenas process. Nevertheless, he does feel that the use of fuel oil has been a great advantage under very difficult conditions in the three following respects: It has assisted in saving coke at a time when coke is high in price and of uncertain quality; it has diminished the labor of handling the cupolas, and it has contributed very largely in cutting down the sulphur in the steel produced.

Fuel Consumption

We do not feel that our figures for oil consumed are necessarily exactly accurate, on account of the difficulties which almost always crop up with oil meters. With this reservation, we give below the consumption of fuels for the

months of June and July and the total number of pounds of metal charged to the cupolas for the same months:

June

2,092,300 pounds of metal charged.
198,974 pounds of coke burned.
2,000 pounds of hard coal burned.
6,970 gallons of oil used.

This gives a total of 10.45 pounds of metal per pound of coke and coal.

July

2,204,870 pounds of metal charged.
187,816 pounds of coke burned.
13,650 pounds of hard coal burned.
9,720 gallons of oil used.

This gives a total of 10.94 pounds of metal per pound of coke and coal.

The writer had hoped to be able to give in this paper much more definite comparisons between operating the cupolas with oil and operating them with coke and if the ensuing year gives an opportunity he will, of course, be able to make the comparisons which would be so interesting. It would, of course, be possible to make these comparisons on iron melted for manganese steel blows, but we cannot spare the extra time and attention to say nothing of the laboratory work that would be needed to make these comparisons. When we are making ordinary carbon steel we analyze, of course, for phosphorus and sulphur but on manganese steel the sulphur content is so small as to be negligible and we accordingly use up the poorer cars of pig iron and scrap on manganese steel charges, and we also use the higher sulphur coke which it seems impossible at the present time to keep out of our shop. It is these conditions and the fact that we, like other foundries, are more than busy in making deliveries that prevent our giving more definite data as to the possibilities of the process.

Effective Means of Improving the Quality of Foundry Sand Mixtures

By Henry B. Hanley, Groton, Conn.

In these times it is, of course, exceedingly important to reduce the cost of foundry sand mixtures, not only by decreasing the amount of new sand used but also by increasing the quantity of old sand that can be used over again.

Sand preparation has only recently received the attention that it deserves, probably because other problems occupied the attention of the foundrymen and were considered more important from the standpoint of the quality of the castings and the cost of production. Different methods of molding mixtures of metal for various weights of castings and for castings for different purposes has occupied the attention of the foundrymen to the exclusion of the now considered important sand mixing department.

There is no doubt that ultimately ways and means will be found to use up all of the old sand; also, that the old cores will be broken up and used over again. Furthermore, unless the foundry is so small that it cannot afford the expense, it is absolutely necessary to employ a metallurgist or chemist to experiment with the different kinds of new sand, to investigate the possible reduction of binder for core sand with the use of cheaper binder than was formerly used, and generally to supervise the more thorough and more economical preparation of molding sands.

It is believed by many engineers who have studied the subject that the most satisfactory means of mixing is by the use of a muller type of machine, provided that the mulling action does not destroy the original structure of the sand, but simply incorporates the various ingredients into

a uniform mixture, at the same time maintaining its original porosity.

Locating the Mixing Department

It is important properly to locate the sand mixing department, so that the new sand can be delivered as automatically as possible into the mixing machine, and to take away the resultant mixture quickly and economically, thus securing the maximum capacity from the mixer. Also, where one machine is used for both facing and core sand, it should be located so that the core mixture and the facing mixture can be transported to wherever they are to be used in the foundry with as little delay and expense as possible. Likewise, the return of the old sand to the machine should be kept in mind, so that the expense of so doing will not counteract the advantage of using up the old sand. It is important that the sand be distributed so that the molders will not have to wait at any time for a fresh supply of sand.

Hand mixing is absolutely a thing of the past, not only on account of the labor conditions at the present time, but also because of the reduction in cost, as obviously it is impossible to reduce the quantity of sand that is required, by hand mixing, as can be done mechanically.

Accurate records should be kept of various mixtures required for certain classes of work and the cost of such mixtures be proportioned per ton of castings. In other words, the cheapest mixture that can be used in any particular class of work should always be determined, and then this particular mixture should be absolutely maintained.

Time of Mixing

The time of mixing should be very carefully investigated, as in core sand especially it is just as bad to mix the sand too long as not long enough, as more expense is necessary in continuing the mix beyond the time required. I have heard a great many foundrymen make the statement that poor sand preparation is responsible for more lost castings than any other cause.

It is also possible with the muller type of mixer to secure a good distribution of sea coal particles for facing, and to decrease the amount of sea coal that is required. Consider the immense saving in time effected by the molder in finishing the mold that is made with well mixed sand; the mold will not fall to pieces so easily and therefore requires less finishing. The metal will not cut into the mold because

FIG. 1—SAND MIXING MACHINE OF MULLER TYPE

the sand presents a tougher exterior. It is not difficult to note the difference, by observation in the cores of the rough, loose edges where the sand is not properly mixed. These edges, of course, are liable to wash off and the pieces get to the top of the casting and cause endless trouble in the machine shop, resulting in the scrapping of the castings.

Where a foundry uses mostly green sand it is all the more important to prepare it properly, especially where there is a variety of castings of both heavy and medium weight.

FIG. 2—CYLINDER HEAD MOLD IN WHICH RECLAIMED FACING SAND WAS USED

In such cases mixtures of sand can be produced with small additions of binder and sea coal that are quite economical. On the other hand, mixtures are required with much stronger bond and more careful manipulation. It is oftentimes desirable to arrange for various bins for the different mixtures, so that there is no chance of using a mixture that is not adapted to the particular class of work to be done.

Another valuable use of the sand-mixing machine is that very tough sand can be cheaply made for large copes because less sea coal is needed and the cope part of the mold is not so apt to scab; also the cope is much less liable to drop out, as is often the case with poor facings.

Description of Equipment

Fig. 1 shows a large cylindrical pan 7 feet in diameter, with sides 12 inches in height. The mullers are supported on steel shafts which are independent of each other. The ends of these shafts are provided with shoes which move in guides in the frame. The muller shafts are supported by heavy steel springs which may be set in such a position that the mullers are close to but not in contact with the muller plates when the pan is empty. The space between the mullers and the muller plates can be adjusted to suit the blending requirements. A mechanical unloader permits of emptying the machine while running.

In our experience with the muller type of sand machine, we found it important to make a careful adjustment of the mullers so that they do not rest on the pan. In this way there is little danger of grinding the material to a powder. On the other hand, if the muller is in contact with the pan a continuous grinding goes on which is harmful for any sand. In the first place, the grain size and grade of the mixture is altered and the whole mass is broken into fine, sharp particles. When such sand is dumped out, it does not feel right, is weak and very sharp. With proper attention to the position of the muller excellent sand can be obtained at all times in not exceeding five minutes time of mulling. This will give the maximum bond for the mixture used. Mulling for three minutes will give nearly the same bond

FIG. 3—METHOD OF MOLDING WITH IMPROVED AND RECLAIMED SAND

as five minutes. The ultimate bond is dependent on the mixture used, the temper, the revolutions per minute and the time.

Influence of Additions of Sea Coal

While conducting a number of tests on green sand facings that contained sea coal, we were surprised to find that the sea coal had a serious effect on the bond. Tests were made to determine to what extent sea coal could be used in good facing and still have the bond required for safe working. A mixture was made of old sand 60 per cent and new sand 40 per cent, no sea coal being used. The molds were blacked, and the casting came out fine. Next, 3, 6 and 9 per cent additions of sea coal were tried. On passing 6 per cent the bond was so seriously weakened that quite poor castings were produced. All of these mixtures were prepared in the muller previously described and were mixed in five minutes mulling. After a careful investigation, it was learned that the sea coal breaks up the continuity of the bond imparted by clay or impurities. This weakness attributed to sea coal could easily have been overcome by additions of more new sand, but since this means increased cost for facing it was decided to adopt the safe working limit of 6 per cent for facing intended for medium weight castings.

Reclaiming Old Sand

In selecting molding sands, we have tried to secure strong bond sands at all times. We find there is economy in the purchase of these strong bond sands because they will go further than a sand of weak bond in adding to old sand or in making a facing. One can appreciate the effect of adding 10 per cent of extra strong stove plate sand to the heap sand, when to begin with the stove plate sand selected for this work contains double the bond of other sands. There are some advantages about reclaiming old sands with strong bond new sands, that should appeal to those who do not have a muller. It is not so difficult to mix thoroughly

FIG. 4—AIR COMPRESSOR CYLINDER MOLD

the two sands as it is when the mixture of clay is undertaken.

To make clear the influence of selected strong bond sands for reclaiming purposes, our experience has been that they are economical and safe in plants where there are no means of controling the reclamation work, such as tests that show exactly what the bond and other qualities are.

Reclaiming Sand with Ordinary Fire Clay

We have found that fire clay is not suited to molding sand work for the simple reason that it takes too much clay to develop the bond when added to old sand. The reason for this is the fact that fire clay does not possess any amount of plasticity but is generally nonplastic. We have found additions of 10 per cent fire clay a serious detriment in sands intended for facing, because with the clay in the old sand plus the added clay which made a total of 20 per cent, troubles in venting and blowing developed. On cutting the fireclay addition down to 5 per cent, the troubles were eliminated, but the bond was not reliable. If the molds dried out from long standing the cope would drop from weak bond. When mullers were first introduced for sand reclamation, it was thought possible to take any foundry clay, add old sand, and make new molding sand. This idea is disappearing, because the knowledge of clay today shows that there is a great variety to select from, each having a different bond and plasticity. Excellent results are obtained when the proper clay is chosen for the work, as the following table indicates:

	Ordinary Fireclay	Selected Plastic Clay
Bond absorption figure	2000	12,000
Transverse strength.	15 lbs. per sq. in.	275 lbs per sq. in.
Clay substance plus impurities, per cent	96 per cent	98 per cent

In selecting the clay to be used, a strong bond plastic clay should be specified. As the table shows, practically the same amount of clay is used, but its quality and its influence on the ultimate strength or bond of the sand being reclaimed

FIG. 5—WORKING CYLINDER MOLD IN WHICH RECLAIMED SAND WAS USED

will differ enormously. This has been explained previously and is due to the superior physical quality and not the chemical quality of the selected plastic clay.

Reclaiming Sand with Selected Plastic Clay

When one changes from the use of ordinary fireclay to a strong plastic clay and attempts to rejuvenate the old sand, an entirely different result is obtained. With the plastic clay, a good strong bond that is reliable is secured. Only a small amount, 5 per cent or sometimes less, is required to develop an excellent feeling in the worn-out sand. This is a tempting line of investigation because it offers a considerable return, on account of the great economy possible. Backing sand for heavy work needs nothing more than a small amount of plastic clay and a few minutes in the muller. When one considers the vast differences in properties of clay that are suitable for this line of work, it is easily understood that the future advances will be made not by using the ordinary fireclay but the selected plastic clay.

Method of Adding Clay to Sand Mixtures

It is still a matter of argument between foundrymen as to the best way to blend sands in order to get the best results. Some prefer the dry mixing method and then tempering; others prefer to mix and temper at the same time. Our experience has shown that wet mixing in a muller develops about all we expect from the ingredients. We have had the best results by adding clay in the form of emulsion, while the machine is in operation. This allows the clay to spread over the surfaces and avoids lumps in the mixture. It is entirely a matter of clay dispersion over sand surfaces that makes ultimate bond. We all know that a liquid condition for the added material is superior to the dry condition. By mixing the clay with water we can develop the maximum amount of bond with the minimum amount of clay.

Utilization of Local Sands

When we have a muller at our disposal, we find that it is thoroughly practicable to utilize some of our local sands by

adding 25 per cent to our new facing sand mixtures. In this way we are saving 50 to 75 per cent against the cost of new molding sand brought from long distances. A good mixture for medium weight castings can be prepared in a muller by taking 50 per cent old sand, 25 per cent local sand, 23 per cent of new sand and 2 per cent of selected plastic clay. It is of importance, however, to first know that the local sand is of refractory character. It matters not whether it contains clay or other bond; this can be put into the mixture at will.

Quality of Work with Reclaimed Sand

The quality of the work produced is the main consideration in sand reclamation. The results obtained so far are decidedly in favor of mechanical treatment of the sand. When a mixture is found satisfactory for a certain line of work it can be duplicated, thereby giving each molder the same quality of sand. This avoids the personal equation where each man thinks he is better prepared on his own facing requirements than the next one. We have seen hundreds of important castings come exactly the same in surface appearance day after day. They were not made from exactly the same formula for sands but the texture and bond were what was required for the job. In order to have complicated castings free from sand defects it is necessary to give the sand mixing some study.

Figs. 2, 3, 4 and 5 show a variety of dry sand molds in which we have successfully employed improved and reclaimed facing sand. The molds are for diesel engine castings.

The Use of Positive Displacement Blowers in Cupola Practice

By W. TRINKS, Pittsburgh

In the application of blowing equipment to cupolas, two questions invariably come up, namely how much air is required, and against what pressure must this air be delivered?

It would be a great satisfaction to engineers and metallurgists if these questions could be answered on the basis of logical reasoning. The latter would probably run along the following channel: The melting and superheating of iron in the cupola requires a known amount of heat per unit weight of iron. The heat is furnished by the combustion of coke. However, only a fraction of the heat of combustion is available, varying with the composition and temperature of the flue gases. But the temperature and the composition of the flue gases depends upon the depth of stock or burden and upon the ratio of iron to coke. If the stock be shallow, holes or pipes are formed through which the air rushes, burning the carbon to dioxide, oxidizing the iron and carrying off large quantities of heat by the large amount and high temperature of the flue gases. If on the other hand the stock be very deep, the cupola is converted into a gas producer. Carbon is burnt incompletely and large quantities of combustible (carbon monoxide) are wasted by passing up the stack.

Experience Must Govern

Somewhere between the extremes, there lies a best condition, which, unfortunately, cannot be determined from theory alone, because the interaction between glowing carbon, oxygen, carbon monoxide and carbon dioxide is so complicated as not to be amenable to mathematical treatment. The best depth of stock, and the smallest ratio of coke to iron must, therefore,

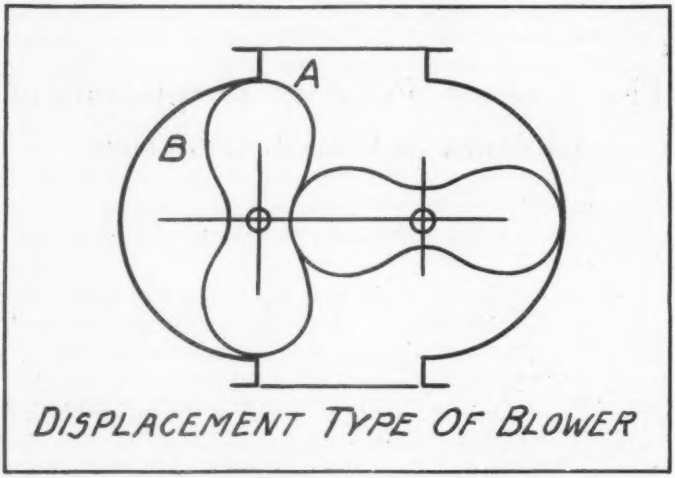


FIG. 1—DISPLACEMENT TYPE OF BLOWER

be worked out from careful experiments in practice. A tabulation of the data gained from experience will be given later on.

It is exceedingly important that these best values which have been determined by experience should be maintained during the melting operation. This means that the rate of charging, the rate of combustion and the rate of melting must be constant and regular. For the latter requirement, a constant delivery of blast is sufficient and necessary. It is the purpose of the present paper to show that the positive displacement blower fills this requirement in a better manner than has heretofore been appreciated.

For the purpose of more strongly bringing out the point in question, the investigation will include both the displacement blower and the centrifugal blower. With apologies to those who are thoroughly familiar with air moving apparatus, the two types in question are shown in Figs. 1 and 2.

Fig. 3 gives the characteristics of the two types of blowers, by which word is meant the curve expressing the relation between *volume of air delivered by the blower* and *discharge pressure,* both for a given intake pressure and for a given speed

of the machine. It will be noted that, for a given change of pressure, the delivery of the centrifugal machine varies much more than that of the displacement machine. The same illustration also contains the characteristic of a cupola for a given depth of stock, given brand of coke, etc. By characteristic of a cupola is meant the curve showing how the pressure at the wind box varies, if more and more air is delivered to the cupola. This curve is parabolic in character. The point where the cupola characteristic and the blower characteristic intersect determines the pressure and the air delivery which establish themselves.

Fig. 4 is a duplicate of Fig. 3, except that several other cupola characteristics have been added. These characteristics

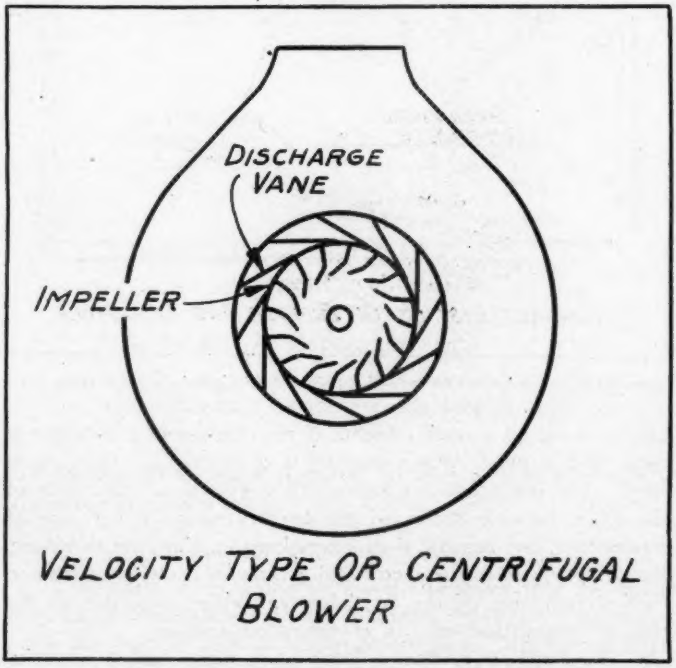


FIG. 2—VELOCITY TYPE OR CENTRIFUGAL BLOWER

belong to different depths of stock in the cupola. It is evident that the resistance to flow is greater with a deep burden than it is with a low burden. The cupola characteristics have been marked low resistance, average resistance, high resistance. For the sake of simplicity, assume that charging is practically continuous. Also assume that, for some reason or other, the resistance to flow through the cupola is temporarily increased, for instance by slag clogging up a tuyere. Then the air deliv-

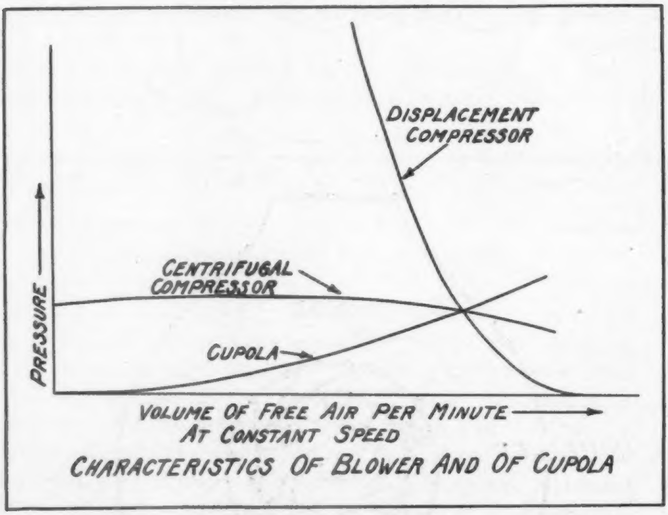


FIG. 3—CHARACTERISTICS OF BLOWERS AND OF CUPOLA

ery is decreased a small amount, if the displacement machine is used, and a much larger amount if a centrifugal machine is used. The immediate consequence is a growth of the depth of the stock, because decreased air delivery means lower rate of combustion, and because the melters keep on charging as before. But a higher stock line means still greater increase of resistance, further reduction of the air delivery, further reduction in the rate of combustion, etc., in a cumulative manner.

The cumulative effect is very pronounced with a centrifugal blower. It is the principal reason why that type of blower

has not been able to hold its own, in spite of certain conveniences which its use offers.

According to the diagram, Fig. 4, a similar effect should be noticeable with the displacement blower, except that its lack of stability should be smaller and in consequence the changes in rate of delivery should be very much slower. Yet practical foundrymen know that the lack of stability under discussion is wholly absent with the displacement machine. The feature

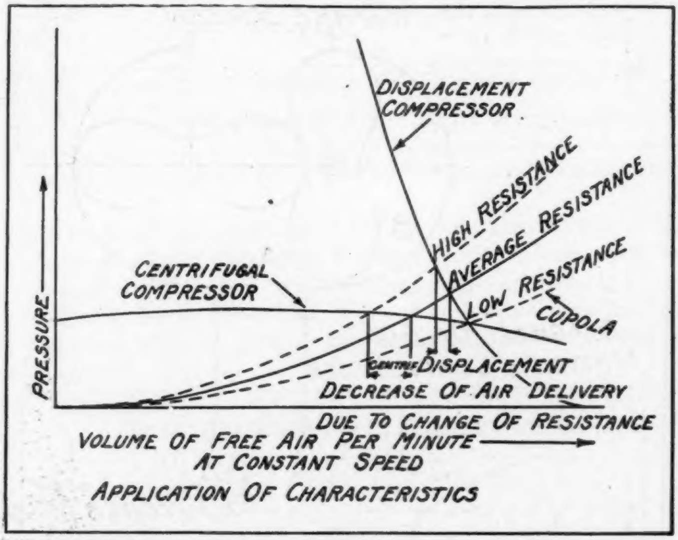


FIG. 4—APPLICATION OF CHARACTERISTICS TO VARYING CONDITIONS

causing this difference is vibration in the discharge line of any displacement blower.

Why Vibration is a Help

The vibration is caused by the circumstance that the space *B* in the position shown in Fig. 5 carries atmospheric pressure, while the space *A* carries discharge pressure. An instant later *B* is in communication with *A* and a weight of air depending upon the pressure difference between the discharge and the inlet

rushes back into B until the pressures are equal. Evidently the delivery of air is diminished during the period of flow-back or of pressure equalization. Figs. 6, 7 and 8 show the ideal rate-of-delivery curves for ½-pound per square inch, 1 pound per square inch, and 1½ pounds per square inch pressure in the delivery pipe. In these illustrations are likewise marked the pressure fluctuations which under average cupola service conditions establish themselves as a direct result of the vibrating rate of delivery. While, in some kinds of blower service a steady stream of air with little or no vibration may be desirable the very same vibration is extremely beneficial in cupola operation. It should be noted that the vibration can be practically eliminated in cases where its presence is harmful by forming the discharge end of the blower in the shape of an air chamber.

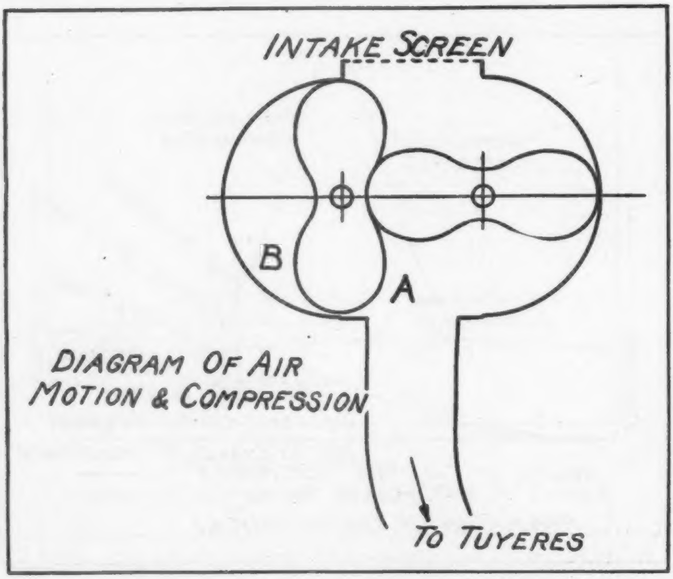


FIG. 5—DIAGRAM OF AIR MOTION AND COMPRESSION

Going back to the example of a slight increase in the resistance to flow, caused for instance by the clogging up of a

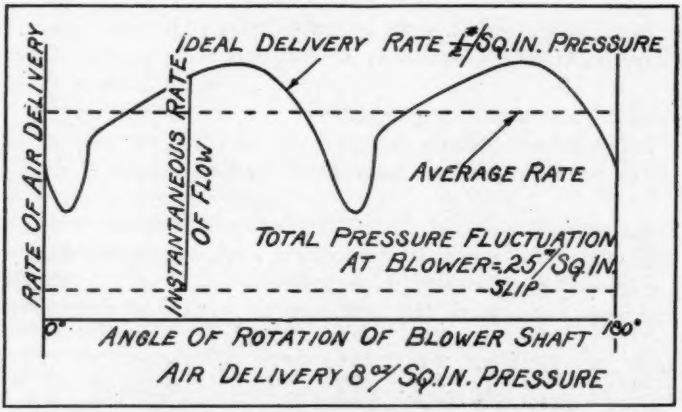


FIG. 6—AIR DELIVERY FOR 8 OUNCES PER SQUARE INCH PRESSURE

tuyere, it follows from Fig. 4 that the air delivery with a displacement blower drops only a little. It also follows from the same illustration that the pressure rises considerably. And finally, it follows from Figs. 6, 7 and 8 that the pressure fluctuation or vibration grows. But the combined effect of greater

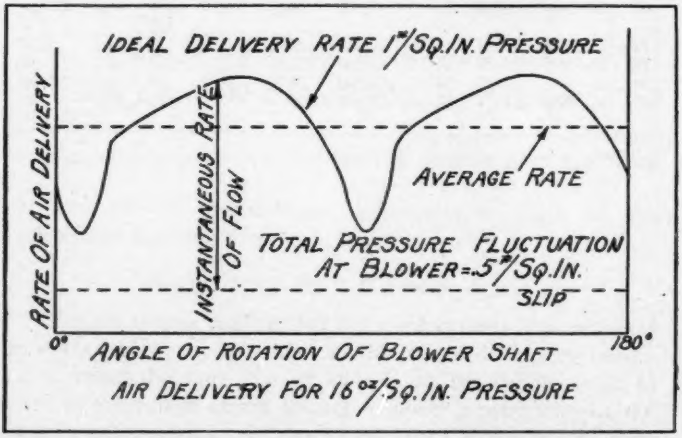


FIG. 7—AIR DELIVERY FOR 16 OUNCES PER SQUARE INCH PRESSURE

RECOMMENDED PRESSURES AND BLOWER SIZES

Dia. inside of lining, in.	No. of tuyeres	Total area of tuyeres, sq. in.	Cap'r tons-hr.	Air: Blast press. oz.	Air: Cubic ft. per min.	Air: Blast pipe dia.	Positive pressure type blower: Size	Sp'd	Hp.	Nozzle dia., in.
18	2	32	¼-½	7-8	300	4*	¼	415	.9	5
23	4	83	½-1	8-10	600	6⅜	1	245	2.2	8
27	8	114	1-2	8-10	1,000	10	1–2	385	3.5	8–10
								245	3.5	
27	8	122	1-2	8-10	1,000	11¾	2	245	3.5	10
32	8	122	3-5	10-12	2,500	11¾	3	335	10	12
32	8	161	3-5	10-12	2,500	14	4	235	11	14
37	8	182	5-6	10-12	3,000	14	4	255	12	14
42	12	270	6-7	12-14	3,500	14	4–5	295	16.0	14–16
								205	16.7	
45	12	312	7-9	12-14	4,500	17	5	255	21	16
48	12	347	9-10	12-14	5,000	17	5½	195	22.8	18
54	12	468	10-12	12-14	6,000	18⅛	5½	230	27	18
60	12	546	12-14	14-16	7,000	18⅛	6–6½	195	35.5	20–22
								150	36.4	
66	12	642	14-18	14-16	9,000	24⅞	6½–7	190	46.2	22–24
								158		
72	12	828	18-21	14-16	10,000	24⅞	7	175	51.2	24
78	12	945	21-24	14-16	12,000	24⅞	7½	158	60.7	24
84	12	945	24-27	14-16	13,500	24⅞	7½–8	177	68.5	24–30
87	16	860	27-31	14-16	15,000	30	8	144	76	30

*Two.

pressure and of greater vibration loosens the stock in the cupola to such an extent that the resistance is quickly restored to its original value.

Inversely, should the resistance drop below the normal value, then the pressure will drop considerably, and the vibration will decrease, all of which tends to bring the resistance back to its former value.

The builders of centrifugal and of fan type blowers have persistently pointed out the supposed advantage of the absence of vibration in the air blast coming from centrifugal machines. It is quite interesting to note that this very same vibration

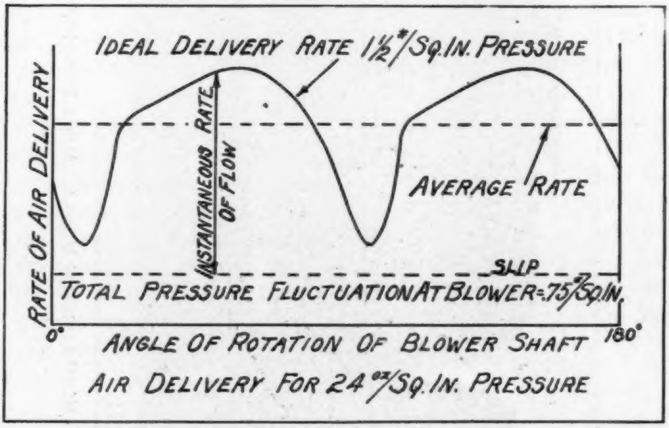


FIG. 8—AIR DELIVERY FOR 24 OUNCES PER SQUARE INCH PRESSURE

furnishes one of the strongest arguments in favor of the displacement machine for cupola service.

Blower Must Be Of Proper Size

While it is thus evident that the displacement blower makes for stable and steady operation of the cupola, it is very important to select the right size of blower for the cupola so as to utilize to the fullest extent the self-regulating properties of the displacement machine. It should be noted that most blowers are now motor driven and that with increasing centralization of

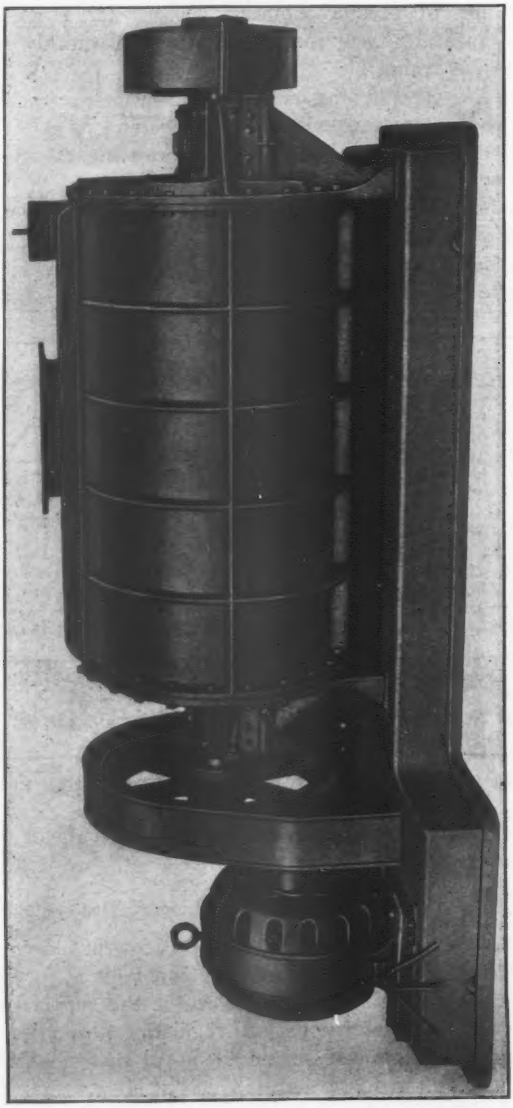


FIG. 9—MOTOR-DRIVEN DISPLACEMENT TYPE BLOWER

power generation more and more of the motors are of the alternating current type. But in this latter type, speed adjustment without loss is impracticable, except in very large units where initial expense counts little compared to everyday saving.

In the sizes of alternating current motors which are used in connection with foundry blower service the speed can never be increased over the economical speed, and can be reduced only at the expense of continually dissipating electric energy.

The accompanying table on cupola practice (which is regularly used by the Roots Co.) will be of assistance in this connection.

If a mistake should have been made in the selection of the size of the blower, it is as a rule cheaper to change the gears or pulleys between the motor and the blower than to put up with the continued losses day by day. For if the blower be too small the melting capacity is reduced which means a loss in tonnage, and if the blower is too large too much heat goes up the stack, while the iron is oxidized. These losses can be avoided by opening a bypass on the blower, but that means loss of power and interference with the self-regulating features of the blower. However, there is really no excuse for selecting the wrong size of blower, except perhaps the necessity of buying a second-hand machine to avoid initial expense. But usually the purchaser in such a case pays dearly in the long run for the initial saving.

Reliability a Factor

Turning to another feature in the use of positive displacement blowers for cupola service, I may say that they are exceedingly reliable. This does not mean that troubles never arise with displacement blowers. They occasionally do arise, but every case of trouble is due to one of two causes: Either the machine was not set properly, or else there existed utter lack of even the first elements of care and attention.

Let us take up these two points in the order given. It will for instance not do to support the blower, Fig. 9, at the right hand end only and to leave it unsupported at the left, because in no type of machines are bedplates made rigid enough to take up overhanging weights without deformation. The manu-

facturer who made bedplates rigid enough for taking up overhanging weights or foundation bolt pull without deformation would soon go out of business, because his machines would be so heavy as to make the price prohibitive. In consequence, bedplates are made strong enough to bridge over small irregularities in the support. Hence, a blower must not be set up on a very irregular surface and then bolted down; it should touch the supporting surface in several places, not too far apart, before the bolts are tightened. If necessary iron wedges may be used.

Platforms Should Be Rigid

In foundry practice, it has more and more become customary to place the blower on the charging platform, to take air in from above and to discharge it downwardly toward the tuyeres. This arrangement saves much space and takes the blower away from the dirt of the floor. With this arrangement it is very desirable to make the structural material supporting the blower very rigid, so rigid that no deformation can take place. This goal is reached if the girders are figured from structural tables to support a weight of four to five times that of the complete blower, bedplate and motor. It must be remembered that clearances in bearings are a few thousandths of an inch and that deformation of a few thousandths will, for that reason, cause heating and excessive wear.

A similar condition exists with regard to pipe connections. Piping which has to be pulled into place by bolts deforms the casing of the blower and may cause touching of the impellers in spots. All of these precautions should be observed just as much for centrifugal blowers and pumps as they should be for displacement blowers. In fact, I have experienced trouble with improperly set centrifugal pumps.

The second feature is one of care and attention. No matter how much we may strive to make machinery foolproof, it will require some attention. Positive displacement blowers have self-oiling bearings which are closed against dirt and dust, and have self-oiling gears. And yet, with all these precautions, the lubrication is not that of the ideal oil bath, which is the dream of every designer of machinery. Accordingly, slow wear

occurs. Every few months the dirty oil must be drawn off and replaced by clean oil. The machine should be inspected at least once a week to see whether wear may have taken place due to some unforeseen reason. Undue wear can usually be discovered from the color of the oil, or from a scraping noise of the impellers in the casing.

Clearances Should Be Checked

Once a year the inlet screen should be removed, the impellers should be placed vertical, one after the other, and the clearance between the top of the impeller and the casing should be checked up. The bearings are adjustable so that the correct clearances can easily be re-established if wear should have occurred.

If these few precautions are observed, positive displacement blowers last for generations, and will be free from the disagreeable noise which a neglected blower makes.

Very little need be said concerning the economy of the displacement blower. With pressures below one pound per square inch, the efficiency of the displacement blower is very high, and frequently exceeds 85 per cent.

The greatest value of papers of this sort lies in the discussions which they start. For that reason the author will welcome criticisms, friendly or otherwise, particularly if the discussion comes from practical foundrymen.

Discussion

THE CHAIRMAN, MR. B. D. FULLER.—Professor Trinks' paper opens up the old argument between the fan and the blower, but he has mentioned something which is entirely new to me, and that is the effect of the vibration of the positive pressure blower on the cupola, in case of blocking up the charges. I know that on the question of operating the blower when the cupola is blocked up, a waste of power results. Now a

fan is entirely different. If you block up in front of a fan, you don't use the power, because you don't take the air in the fan. The proper operation of a cupola with a fan is simply a matter that is in the hands of your cupola operator. I contend that a cupola can be run just as successfully with a fan as a blower, if you have a fellow that will keep the air passages open in the tuyeres. I use them both and am not showing favor between one and the other.

Pyrometers and Their Application to Core Ovens

By G. W. KELLER, Philadelphia

In the use of pyrometers for core ovens and mold drying ovens there are a number of different types and methods of applications to be considered. The first applications of pyrometers were made some 20 to 30 years ago of an older type. Some of these pyrometers are still in service as they are extremely rugged with no fragile glass parts to become broken. This older form of pyrometer is commonly known as the expansion pyrometer, as it operates on the difference in the expansion of metals. While it has not the degree of accuracy for measuring temperature of instruments of more recent development, it proved of sufficient value on account of its durability to warrant its use over a period of many years. More modern instruments, however, have gradually superseded this type, namely the electric indicating and recording pyrometers, and the gas-filled indicating and recording thermometers.

Older Forms of Pyrometers

As a matter of interest it may be worth while to devote a few moments to the general construction of the older form of pyrometer as well as the later types. The first form of pyrometer, commonly known as the expansion pyrometer, operates through the difference in expansion of a steel stem enclosing a graphite rod. A pointer is attached at the top and by means of a spring the change in expansion is exaggerated and the pointer swings around a circular dial as shown in Fig. 1. The scale on this instrument can be made very open, as approximately 320 degrees out of a possible 360 is used for the circular scale.

However, the great disadvantage of this form of instrument is that the indicating or recording part of the instru-

ment must be connected to the steel stem. In the case of the electric pyrometer or gas-filled long-distance thermometer, the instruments may be located at a distance where it may be more convenient to observe them.

A pyrometer which may be extended to meet practically all conditions is the electric pyrometer using base metal thermocouples composed of wires properly protected with steel or iron sheaths. These thermocouples, constructed as shown in Fig. 2, are usually about 3 feet long and are placed in each core oven, and several may be connected to one indicating instrument properly graduated to approximately 800 to 1000 degrees Fahr. The elasticity of this equipment can readily be noted, as by means of a switchboard with contacts, each one representing a thermocouple, any number of core ovens may be connected to a central station pyrometer, as shown in Fig. 3.

Construction of Thermocouples

Thermocouples composed of two wires of slightly different alloy, welded at one end, generate a small electric current. This electric current is transmitted to the electric pyrometer by ordinary copper wire. You can readily note that the construction of the thermocouples is even more robust than in the expansion type of instrument. They are provided with an outer protecting sheath that does not form one of the elements. Direct oxidation or burning away of the thermocouple elements at moderate temperature is practically eliminated. The electric wiring is easy to string and will permit the instrument to be located where it may readily be observed by the core oven tender.

Electric pyrometers have been in service for many years, particularly among malleable iron and steel annealing plants. This is probably due to the fact that at higher temperatures it has been the common belief that greater attention should be paid to the temperatures at which the metal should be annealed. Within the last two or three years, however, it is recognized that in order to secure good castings, the proper attention must be given to the making of the molds and the drying of the cores.

Instead of the crude brick core ovens such as can still be seen at the older iron foundries, more modern types of ovens

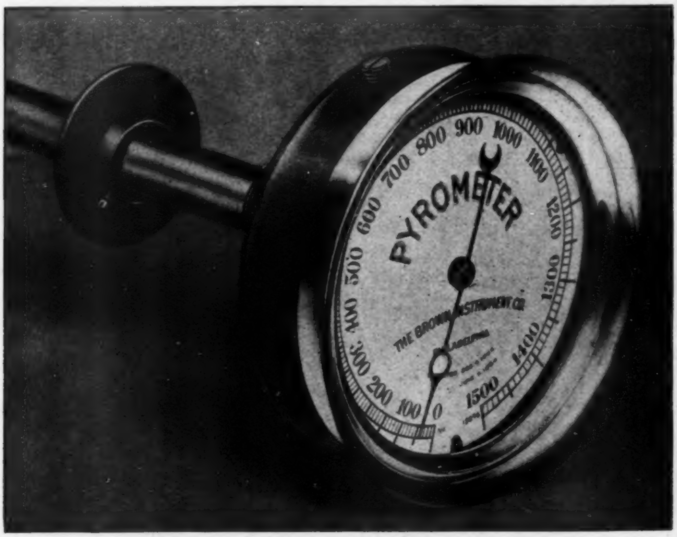


FIG. 1—OLDER FORM OF PYROMETER

are now used, many of which have been carefully designed for better combustion of the fuel. Large core ovens are

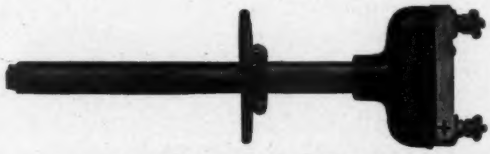


FIG. 2—CONSTRUCTION OF THERMOCOUPLES

still generally built of brick, though small core ovens are frequently composed of a brick lining with sheet metal covering. This presents a neat and finished appearance. Instead of the crude doors which allow the loss of heat at a great

expense and wastage of fuel, modern core ovens have either a metal door which is raised by a counterweight, or is of the more modern roll types.

Avoiding Green Cores

By carefully checking up the temperatures of the core ovens you anticipate any trouble in the castings which may occur due to green cores. You eliminate questionable results which may occur due to changes in oven temperatures which formerly would not be observed by the oven tender. The drying of the cores can be placed on a more scientific basis.

It is natural that a large core should take more time than a small light core. The maximum temperature should not be exceeded, but the average length of drying must be carefully studied. At many plants they frequently fill the ovens with all dimensions and sizes of cores. As a result it is natural that if the oven is unloaded at the proper time for the light cores the heavier ones will still be green. In such instances the time element must be the average for the lot when they cannot be separated into sizes and dried.

Exact Knowledge of Temperatures

Pyrometers take away from the oven tender the worry as to what his temperatures are. They also furnish the superintendent or manager with valuable data as to what temperatures are best for certain sizes of cores. In this respect the process is similar to the heat treatment of steel and other metals. Before the extensive use of pyrometers, the management depended entirely upon the skill of the hardener whether the results of heat treatment were properly secured. In the early days, the heat treatment of metals was not considered of such great importance as it is at the present time. The hardener usually either tested the steel with a magnet to determine its hardening point or merely guessed when the temperature reached the hardening point. He had no idea what the hardening point of the steel actually was. The critical or transformation points of steel were unknown quantities.

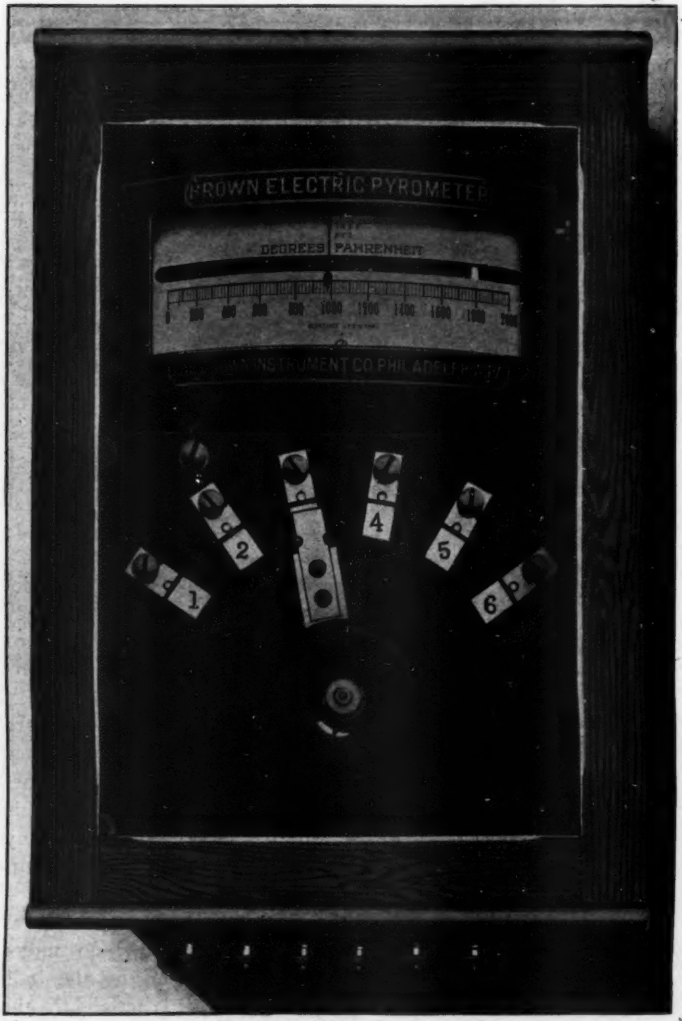


FIG. 3—A GROUP OF CORE OVENS CONNECTED TO A CENTRAL STATION PYROMETER

Since the roller bearings and crank shafts of automobiles, tractors, etc., depend considerably for their durability on the heat treatment they receive, more attention has been paid to this process and the responsibility largely taken away from the actual man who heat-treats and placed on the shoulders of the metallurgist, superintendent or some other specialist.

This same advance in efficiency is now under process in the foundry. Castings cannot be expected to stand the strain placed upon them unless they are properly made. Improvements in the manufacture of castings are fast being incorporated at many plants. At one time it was considered only necessary to brush the casting with a stiff wire brush. Since then sand blast has been used with better success. It is necessary to adopt improvements to keep pace with the other allied lines of the metal industry.

Recording Instruments

While the description above has covered more particularly the indicating type of pyrometer equipment, recording electric pyrometers are also frequently used and in fact a recording instrument adds considerably to the efficiency of the pyrometer equipment. Where there are a number of core or mold drying ovens, the recording long-distance thermometer of the gas-filled type is frequently used. It is necessary to use one instrument for each oven and where there are a number, it is slightly more expensive. Their installation should be given careful attention as with a gas-filled bulb and copper tubing care must be taken that this tubing is installed out of the way of trucks or injury from any cause. The tubing is protected with a flexible steel armor, but this can be injured if carelessly installed.

The gas-filled recording thermometer in its operation is based on the principle of a nitrogen gas-filled bulb under pressure. This gas expands upon the insertion of the bulb into heat and the pressure thus exerted is carried to the recording instrument which may be attached at the side of the core oven or at any distance within approximately 100 feet of the bulb. A record is produced by a pen arm attached to

a coiled helical tubing at the end of the steel armored tubing. This recording arm swings out over the scale, as shown in Fig. 4.

At one plant where they operate a large core drying

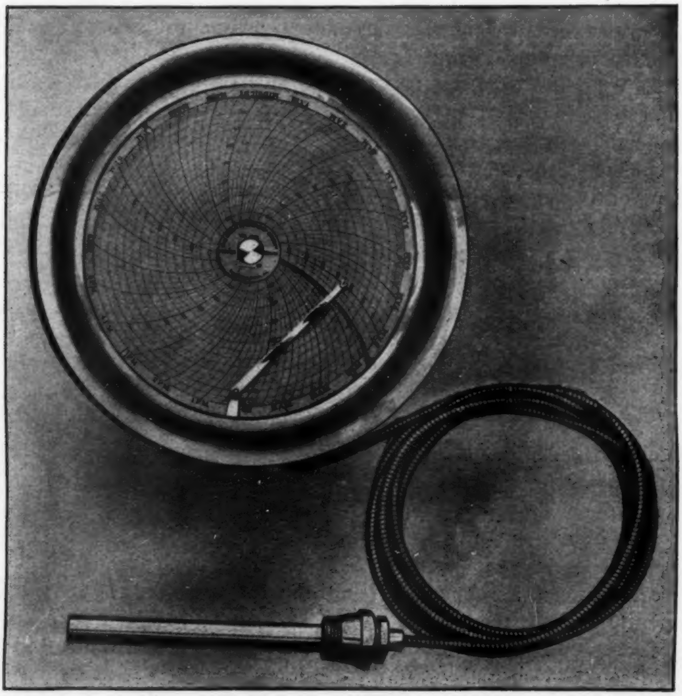


FIG. 4—RECORDING ARRANGEMENT OF GAS-FILLED RECORDING THERMOMETER

oven and also an oil-fired mold-drying oven, since the installation of recording thermometers, the man in charge especially at night, who is frequently only a watchman, properly attends to the ovens, so that the molds are not dried nor burned. Recording thermometers will also safeguard the output as should there be any change of oven tenders due to sickness

or other cause, there would be sufficient data on file to enable the continuance of the ovens without danger of loss.

A Complete 24-Hour Record

The charts produced furnish a record for the entire 24 hours, as shown by the facsimile chart reproduced, Fig. 5. Instructions may be given the night man so he can readily see from the previous temperature curve just what the oven has been doing from the start. This also serves the superintendent or manager as a check, as the records are usually handed in the next morning and at a glance the superintendent or manager can readily note whether the ovens have been properly fired. If the night man should fall asleep, naturally the record would clearly indicate this by a change or falling off in temperature.

Probably one of the most important advantages just at this time is the saving of fuel, whether it is coal, gas or oil. Even though a slight percentage of fuel be saved per day, it is one step in the right direction.

At one plant which recently changed management, the new manager who had previously used pyrometers on his malleable iron annealing ovens, immediately upon taking charge of the iron foundry, equipped his core ovens with recording thermometers. It evidently was one of the first improvements that received his attention, as he undoubtedly realized the importance in accurately controlling the temperatures of his annealing ovens, and the very similar process of controlling his core oven temperatures though at a considerably lower temperature. Undoubtedly there will be vast improvements in the construction and application of pyrometers for this purpose in the near future.

Automatic Temperature Control

The automatic control of the temperature in core ovens is quite possible where fired by gas or electricity. In fact, an automatic control pyrometer suitable for this purpose has already been developed. It is operated through electric switches or solenoid operated valves which partly open and

close the electric circuit of the electric fired ovens or the flow of gas in gas fired ovens.

In developing such equipment together with other new types of temperature measuring apparatus, the pyrometer manufacturer greatly appreciates the co-operation of the user of such equipment. Practical demonstration of newly devel-

FIG. 5—RECORD OF 24 HOURS' OPERATION

oped apparatus can be made much better when in actual service than in the laboratory of the pyrometer manufacturer. The advantage of this co-operation is probably more in favor of the user as he receives more direct benefit from the continued service of the pyrometer equipment.

As a brief summary of the more pronounced advantages in the use of temperature measuring apparatus, it would be well to consider the following:

First:—Eliminates guesswork as to the temperature inside the ovens.

Second:—Serves as a practical guide for the oven tender by which to gage the time period of core drying.

Third:—Lowers fuel consumption through maintenance of correct temperatures.

Fourth:—Serves as a check on the operation of the ovens and furnishes important information to the manager or superintendent.

Unquestionably the increased efficiency of plant operation in the future will include more careful control of core and drying oven temperatures along with other improvements. Co-operation between the manufacturer and instrument makers is to be hoped for now, more than ever before.

A Pouring System for Modern Foundries

By MARK P. OHLSEN, Brillion, Wis.

For many years progressive foundrymen have been studying the problem of handling molten metal. In many cases the production of molding machines is limited by the ability of men to pour off their floors. Any method, therefore, which can be devised for increasing the amount of metal one man can pour will have a direct effect on the production. In the comparatively few shops where complete pouring systems have been installed, the results have been exceedingly gratifying and the investment in pouring apparatus has been rapidly repaid. The fatigue element should not be overlooked in considering the installation of a mechanical pouring system. State laws regarding hours and conditions of labor are rapidly becoming more stringent every year and the foundryman who does everything he reasonably can to ameliorate the working conditions in his shop finds that he not only keeps on the safe side of legislative enactments, but usually also increases his profits owing to the more efficient work obtained from thoroughly satisfied employes.

The labor shortage resulting from the operations of the draft law also has a direct bearing on the pouring problem. Pouring is not pleasant work and under existing conditions it is not uncommon for ordinary laborers to refuse to help take off the heat. The value of mechanical pouring systems is therefore more keenly appreciated today than during normal times.

The pouring problem also is much more acute in foundries turning out large quantities of light castings than in shops pouring the same tonnage into a few large castings. In the latter case the amount of metal going into each mold is so

large that crane ladles must be employed and the actual exertion required is greatly reduced. In some of these foundries 100 tons of iron may be poured into three or four castings, but in foundries specializing in automobile work, agricultural implement castings, sewing machine or typewriter parts, pipe fittings, small parts for marine engines, light artillery castings, etc., the pouring problem is a real one. In one of the large automobile foundries in Detroit, for instance, over 100 tons of iron is poured per day into castings with an average weight of only 28 pounds.

Complete Pouring System

A complete pouring system for a gray-iron foundry handling light work should include apparatus for handling the metal at the cupola, for transferring it to the various floors and for pouring it into the molds. In most foundries at the present time some arrangement is made for transferring the molten metal from the cupola to the floors by mechanical means, even though the actual pouring may be done by hand. Where the average weight of the castings is large, crane ladles of from 1 to 4 tons capacity handled by the regular traveling crane are fairly satisfactory. The crane transfers the metal to the extreme ends of the shop very quickly and most plants are so arranged that the floors are accessible from the crane runway. For lighter work some sort of an overhead system is found more satisfactory and this system should include a device for actually pouring the metal into the molds, as well as means for getting it from the cupola spout to the point where it is finally poured.

The system which it is the purpose of this paper to describe in detail was invented originally for use in the shops of the Brillion Iron Works, where a large number of gray iron castings are made daily. Where a device of this character is used the iron should be distributed to the various floors either by trolley ladle or by some other means. Each floor is equipped with a small, easily-operated hand crane or trolley which usually runs across the shop at right angles to the distributing ladle tracks. This hand crane or trolley carries a small ladle from which the molds are poured. In most shops the cupolas are located near the middle and the

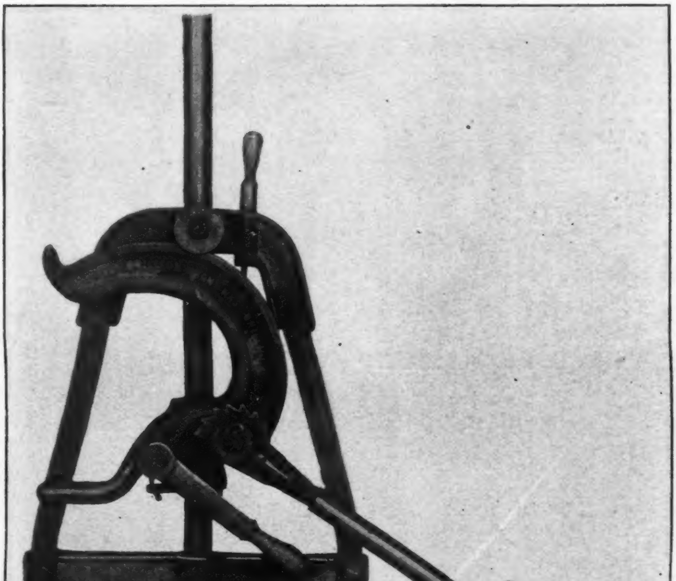


FIG. 1—POURING DEVICE SUITABLE FOR HANDLING 350 POUNDS OF IRON

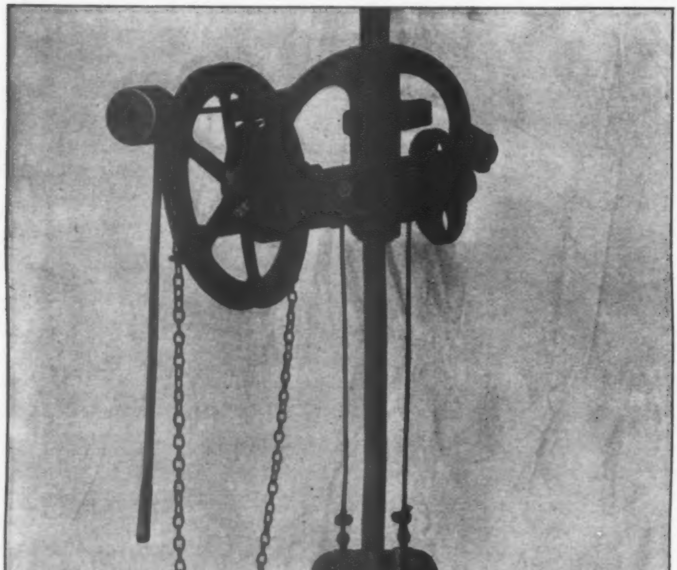


FIG. 2—POURING HOIST DESIGNED FOR LOADS UP TO 2000 POUNDS

distributing ladle makes alternate trips to each end of the molding room. The operator of the distributing ladle controls the filling of the small ladles. The latter are handled entirely by the molders, who not only pour off the floors but in some shops shift their own weights. The general arrangement of the system is clearly shown in Fig. 3. Figs. 1 and 2 give a detailed view of the pouring ladles.

Details of Pouring Device

The pouring ladle yoke is suspended from the lower end of a piece of pipe or steel of convenient length as indicated

FIG. 3—POURING MOLDS BY MEANS OF OVERHEAD CRANES

in Figs. 1 and 2. The ladle itself is carried in a bail to the shaft, to which the tilting lever is attached. For handling up to 350 pounds, the yoke slides over the suspension bar and rests on a large cam which is held in position by a pawl. When the pawl is released the yoke and ladle may be raised or lowered a distance of about 10 inches by operating a lever connected with the cam. Upon receiving metal from the distributing ladle the pouring ladle is brought to its lowest position and is afterwards raised to any height convenient to the operator within the range of the device. The metal shield which is secured to the yoke over the ladle

protects the molder's eyes from the intense glare of the hot iron. This, it is said, results in more accurate pouring and fewer spills. The men also appreciate the release from eye strain. For handling up to 1000 pounds of iron the heavier construction shown in Fig. 2 is employed, in which a geared hoist takes the place of the cam.

The overhead trolley which carries the pouring ladle is made up of brackets to which turned wheels 12 inches in

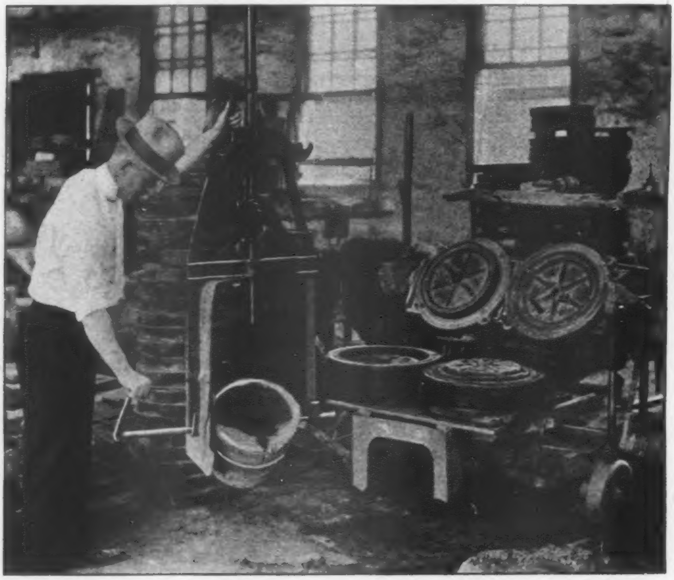


FIG. 4—THE SHIELD PROTECTS THE WORKMEN FROM FLYING PARTICLES OF HOT IRON

diameter are attached. These wheels are fitted with roller bearings to cut down the friction loss. The tread of the wheels is turned to accommodate the 16-pound rail on which the trolley travels. This arrangement is designed to withstand a load of 1000 pounds. A somewhat heavier type is also built to handle loads of 2000 pounds. In the latter case the brackets are heavier and the wheels are 16 inches

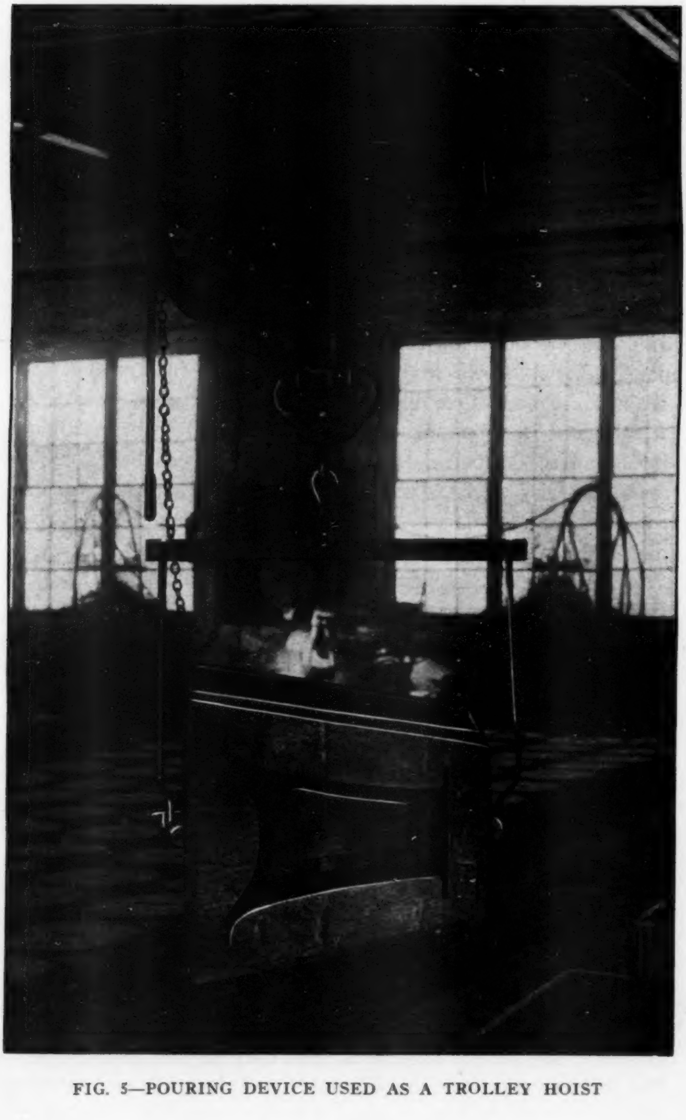


FIG. 5—POURING DEVICE USED AS A TROLLEY HOIST

in diameter. This is known as the 1-ton pouring crane. This crane may run lengthwise of the floor and be equipped with a trolley which runs on the lower flange of the eye beam and travels across the floor so that any point spanned by the crane may be reached by the ladle. The recommended height for a track to accommodate this overhead construction is 12 feet, although a little more or less height is not objectionable.

The pouring device shown in Fig. 1 has a capacity of 350 pounds. It is raised or lowered by means of cams with a range of 10 inches as previously described. This device, of course, is built for the lighter classes of work. The large pouring hoist shown in Fig. 2 is similar in construction to a chain hoist and is equipped with cut gears and rope drums which give it a possible lifting range of 60 inches, although the standard is 36 inches. This pouring device has a molten metal capacity of 1000 pounds and a general purpose capacity of 2000 pounds. It can be operated in a minimum headroom of 10 feet, although 12 feet is preferable.

This type of a pouring device is so arranged that the ladle bail can be easily removed by taking out two bolts. This makes it possible to quickly substitute another bail of any desired shape to accommodate other classes of foundry work, as shown in the accompanying illustrations.

The pouring devices developed by the Brillion Iron Works can be used for handling various materials in foundries as well as for pouring. Flasks, for instance, may be shifted from the gangway to the molding machines. Heavy molds also can be handled. With the aid of the 1000-pound hoist previously described, two men can handle molds weighing half a ton with very little effort. The device also is of service in shaking-out flasks.

In the shop of the Brillion Iron Works this device is used for pouring separator stands weighing 48 pounds each. Under the old method of molding, by hand, a man and a helper were able to put up and handle 14 molds in a day. At present, with the aid of the apparatus described in this paper, one of the molders now puts up 22 molds and does his own pouring.

This job requires the use of large cores which also must be handled and set.

Tests which have been made show that when the pouring device is loaded with a weight of 200 pounds, the ladle can be started with a push of approximately 8 pounds and after it is in motion it proceeds almost entirely by its own momentum. For this reason the device has been installed in some foundries where girls are being tried out for light work in place of men who have been called for military service.

A Rapid Method for the Determination of Graphitic Carbon

By Frank H. Kingdon, Claremont, N. H.

Each year brings an increase in the demands on chemists doing foundry work. The increase in the production of cast iron containing steel scrap in variable proportions, and the recent investigations on cast iron has brought the foundry to a point where the element carbon is being considered.

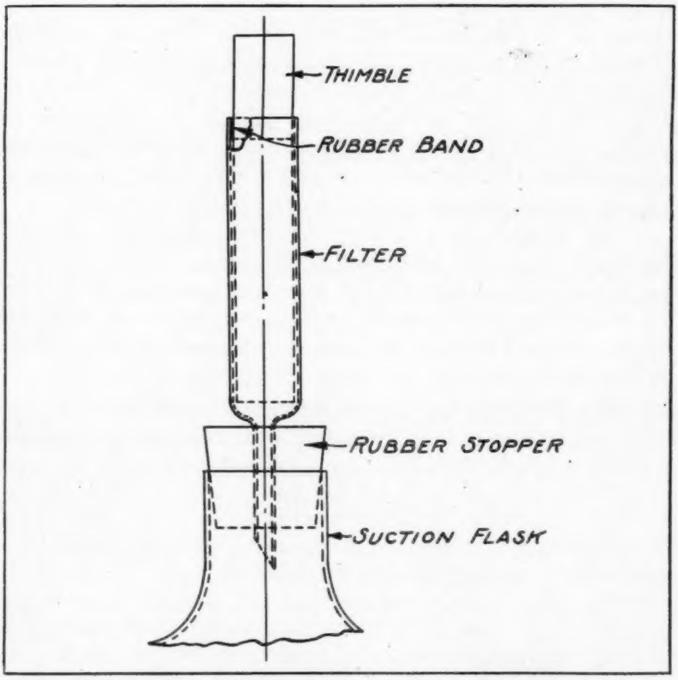
The following rapid method has been found suitable for routine work in determining total and graphitic carbon in cast iron. A brief description of the combustion furnace and train will give an idea of the apparatus used.

Oxygen under pressure is conducted through a Y-glass tube to a Fleming mercury gage at one end, and from the other end to a potassium hydroxide (K O H, 1:1) jar. (E and A, 2796c.) It next goes to a jar (E and A, 2796e), the lower half of which contains $CaCl_2$, the upper half soda lime, then to a mercury valve tube (E and A, 2796a), then to a Hoskins combustion furnace with 24-inch quartz tube glazed.

The outlet part of the train consists of a zinc jar (E and A, 2796h), and phosphoric anhydride jar (E and A, 2796i). The gas is collected in a Vanier absorbent and weighing jar filled with liquid potassium hydroxide (K O H, 1:1) and stick (broken) potassium hydroxide. At the outlet end of the furnace a platinum couple is inserted with a small pressure tight quartz tube through a two-hole stopper so that the couple end is about over the boat position in the furnace. The apparatus is tested for leakage by using aspirator bottles.

Samples of cast iron are ground to pass a 60-mesh sieve. For total carbon twice the factor weight (0.5454

gram) is placed in an alundum boat filled with 90-mesh alundum. Better results are obtained with the use of red lead. From one to two grams of red lead are placed in the alundum boat and the iron sample distributed on the red



CONSTRUCTION OF THIMBLE, FILTER AND SUCTION FLASK

lead. It is advisable to run a blank determination on the red lead.

Boat Placed in Furnace

The boat is placed in the furnace which is at 1750 to 1800 degrees Fahr. and oxygen passed at about 200 cubic centimeters per minute. The combustion proper is complete in from six to eight minutes and from 12 to 15 minutes more is

ample for forcing all the gas through the train into the weighing apparatus.

For the graphitic carbon determination a one-gram sample (60 mesh) is transferred to a 150 cubic centimeter beaker, 40 cubic centimeters of nitric acid (1.13) is added and gentle heat applied until the solution is complete. It is then boiled for five minutes and the graphite allowed to settle. Filter into the thimble as described below using hot water. Wash five times with hot dilute hydrochloric acid, then 10 times with hot water. Place the thimble in a drying oven at 110 degrees Cent. for 30 minutes, then place in the combustion furnace, open end in first, and proceed for regular carbon determination.

The thimble is a Norton alundum extraction thimble, No. 7338—R. A. 360, measuring 15 millimeters outside diameter by 90 millimeters high. This is placed into a carbon filter tube 16 millimeters inside diameter and an air-tight joint made by using a rubber band, as shown in the accompanying illustration. A regular suction flask and water filter pump is used.

The following table gives some of the results obtained:

No.	Sample	Total Carbon Red Lead Used Per Cent	Graphitic Carbon Per Cent
1.	Gov. Iron *C*...........	2.80	2.30
2.	Gov. Iron, *D*...........	2.49	1.90
3.	25 per cent steel.......	3.00	2.20
4.	Gov. Iron *C*...........	2.81	2.29
5.	Gov. Iron *D*...........	2.48	1.89
6.	25 per cent steel.......	3.02	2.19
7.	Gov. Iron *C*...........	2.80	2.29

The 25 per cent steel sample was a cast iron in which 25 per cent of steel was used in the mixture. This iron analyzed as follows: Manganese, 0.60 per cent; silicon, 1.80 per cent; sulphur, 0.107 per cent; phosphorus, 0.40 per cent.

Concrete Foundry Floors

By George Moyer, Reading, Pa.

My practical experiences with concrete foundry floors extend over the past 10 years. I have paid the closest attention to this particular subject and I find the concrete floors to be superior to any other foundry flooring for the following reasons:

The floors can easily be kept clean with very little expense of labor and time.

The molds will always stand level and straight and because of this we avoid the not inconsiderable loss of castings resulting if the molds are not level.

The molder cannot dig holes in the floor with his shovel, which is frequently the case on other floors.

The absolute straight and smooth surface will always give the men carrying iron a safe path and prevent them from stumbling into the holes of an ordinary clay or gravel floor.

Cores Distributed by Truck.

In the foundry with which the author is connected, we distribute all the cores with an electric truck and on account of the concrete floor we can transport in this manner any style of core without breaking it. In case a sand-cutting machine is used to cut the sand the numerous advantages are obvious. The strain on the machine is naturally much less on a level, solid foundation and it can cut all the sand clear down to the ground without taking any chance of damaging the machine.

The argument that concrete is hard on molders' feet does not hold good as experience proves that the molders are always standing on sand just as they do on gravel or clay floors.

In conclusion, I have found the concrete foundry floors to be a complete success and I know that if I would give our molders the choice between clay and concrete floors they would all prefer the latter.

Report of the A. F. A. Committee Advisory to the U. S. Bureau of Standards

The pressure of war activity has prevented the holding of meetings with the officials of the United States bureau of standards on the part of your committee. Nevertheless, we can report progress as the work originally laid out has been continued and even expanded.

Director Stratton informs us that the molding sand investigation of the bureau has been turned over to Prof. H. F. Staley, who is continuing the preparation and investigation of artificial molding sands and sand tests. He is further working on the problem of the reclamation of molding sands, and the preparation of core sands for steel castings. A report will be made when these investigations are further along.

Your committee asks that it be continued and hopes that a speedy termination of hostilities may allow a more concentrated effort to complete the work in hand.

RICHARD MOLDENKE, *Chairman.*
WALTER M. SAUNDERS.
H. E. DILLER.

The Registered Attendance

The following members registered their attendance at the annual meeting of the American Foundrymen's Association, Inc., held at Milwaukee, Wis., Oct. 7-11, 1918:

ABELL, FRED A., superintendent, Aluminum Casting Co., Cleveland.
ADAMS, C. C., secretary-treasurer, Blairsville Iron Works, Blairsville, Pa.
ADAMS, C. E., superintendent, York Foundry & Machine Co., York, Pa.
ADAMS, W. J., president, Federal Foundry Supply Co., Cleveland.
AHARA, E. H., works manager, Dodge Mfg. Co., Mishawaka, Ind.
AIKAWA, Y., Tobata Foundry, Fuknokaken, Japan.
ALDRICH, R. H., general manager, The Aldrich Pump Co., Allentown, Pa.
ALEXANDER, JOHN, foundry superintendent, Harrison Safety Boiler Works, Philadelphia.
ALLENSON, JOHN, superintendent, St. Paul Foundry Co., St. Paul, Minn.
ALTHEN, AUGUST, foundry foreman, Althen Foundry & Machine Works, Lancaster, O.
ANDREWS, E. V., sales engineer, Nordberg Mfg. Co., Milwaukee.
ANDREWS, F., master mechanic, Milwaukee Coke & Gas Co., Milwaukee.
ANGELL, F. R., manager, Northern Malleable Iron Co., St. Paul, Minn.
ANTHES, MAJOR L. L., managing director, Anthes Foundry, Ltd., Toronto, Ont.
ANTHONY, A. H., general manager, The Massillon Steel Casting Co., Massillon, O.
ARMSTRONG, H. T., manager, Wm. J. Oliver Plow Co., Knoxville, Tenn.
ARNDT, F. E., chief draftsman, Galion Iron Works & Mfg. Co., Galion, O.
ARNDT, HAROLD V., superintendent, Strong Steel Foundry Co., Buffalo.
ATWATER, H. R., vice president, The Cleveland Osborn Mfg. Co., Cleveland.
AVEY, D. M., editorial representative, Penton Publishing Co., Cleveland.
AYERS, E. M., general manager, Interstate Sand Co., Zanesville, O.

BAAS, JOHN, foundry foreman, Roe Stephens Mfg. Co., Detroit.
BABBITT, R. M., foreman, pattern department, Kalamazoo Malleable Iron Co., Kalamazoo, Mich.

BACKERT, A. O., vice president, Penton Publishing Co., Cleveland.
BACON, CHARLES C., secretary, Ross Tacony Crucible Co., Philadelphia.
BAIRD, W. E., manager, foundry department, American Gum Products Co., New York.
BALDWIN, R. L., electric furnace salesman, U. S. Steel Corp., New York.
BALKWILL, GEO. W., president, Cleveland Steel Casting Co., Cleveland.
BANNING, C. J., chief inspector, Allis-Chalmers Mfg. Co., Milwaukee.
BARELMAN, EDWARD, treasurer, Gibson Mfg. Co., Ltd., Guelph, Ont.
BARNETT, A., core room foreman, Muncie Foundry & Machine Co., Muncie, Ind.
BARRINGER, J. M., assistant manager, Timken-Detroit Axle Co., Canton, O.
BARROWS, D. T., works manager, T. H. Symington Co., Rochester, N. Y.
BASSETT, W. H., technical superintendent, American Brass Co., Waterbury, Conn.
BATES, GEO., president, Enterprise Brass Foundry, Tacoma, Wash.
BATTENFELD, C. F., salesman, U. S. Molding Machine Co., Cleveland.
BATTENFELD, J. L., sales manager, U. S. Molding Machine Co., Cleveland.
BATTENFELD, J. N., president, U. S. Molding Machine Co., Cleveland.
BAUER, FRED W., Rogers, Brown & Co., Cincinnati.
BAXTER, D. D., salesman, E. J. Woodison Co., Detroit.
BAYER, JOHN, salesman, Federal Foundry Supply Co., Cleveland.
BAYERLEIN, E. C., vice president, Nordberg Mfg. Co., Milwaukee.
BEAKE, O. A., foundry foreman, Warden Kind, Ltd., Montreal, Quebec.
BEAMAN, J. W., Joliet, Ill.
BEAN, W. R., research engineer, Eastern Malleable Iron Co., Naugatuck, Conn.
BECKER, A. J., superintendent, Atlas Foundry Co., Detroit.
BELL, C. E., president, C. S. Bell Co., Hillsboro, O.
BELL, DANIEL, foundry foreman, Dominion Coal Co., Ltd., Glace Bay, N. S.
BELL, HARRY M., molder, Indiana Foundry Co., Indiana, Pa.
BELL, RICHARD S., foreman, New Jersey Zinc Co., Palmerton, Pa.
BENDIXEN, P., general superintendent, Bettendorf Co., Bettendorf, Iowa.
BENHOFF, HARRY, assistant foundry superintendent, National Supply Co., Toledo, O.
BENJAMIN, B., engineer, Australian Electric Steel, Ltd., Sydney, N. S. W., Australia.
BENNETT, T. BEN, foundry superintendent, Maxwells, Ltd., St. Marys, Ont.
BENSLEY, MAURICE, president, Frontier Brass Foundry, Inc., Niagara Falls, N. Y.
BERGER, C. L., vice president, Eastern Malleable Iron Co., Naugatuck, Conn.
BERNBAUM, B., salesman, Buckeye Products Co., Cincinnati.
BETTENDORF, E. J., Bettendorf Co., Bettendorf, Iowa.
BETTENDORF, J. W., president, Bettendorf Co., Bettendorf, Iowa.
BEVER, H. J., superintendent, Otis Steel Co., Cleveland.
BILLINGS, C. E., treasurer, New Haven Sand Blast Co., New Haven, Conn.

Biszantz, Fred, secretary-treasurer, Chalmers Mfg. Co., Lima, O.
Blackmore, W., chief draftsman, National Malleable Castings Co., Cleveland.
Blackwell, Harry E., district sales manager, Pickands-Mather & Co., Detroit.
Blankenhorn, Fred H., secretary, Chicago Steel Foundry Co., Chicago.
Blundell, Fred, secretary, Taylor & Boggis Foundry Co., Cleveland.
Bock, William, foundry foreman, Lakeside Malleable Casting Co., Racine, Wis.
Boekenkamp, foundry superintendent, Iowa Machine Works, Clinton, Iowa.
Boettcher, Max E., foundry foreman, Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Boggis, Taylor H., Gordon Sand Co., Conneaut, O.
Bohm, Henry, foreman, pattern shop, Kohler Co., Sheboygan, Wis.
Bohmker, J. C., general manager, David Bradley Mfg. Co., Bradley, Ill.
Booth, Carl H., president, Booth-Hall Co., Chicago.
Booth, W. K., chief engineer, Booth-Hall Co., Chicago.
Borghardt, J. H., foundry inspector, Dayton Steel Foundry, Dayton, O.
Bosworth, president, Bosworth Ard Machine & Foundry Co., Anniston, Ala.
Bourne, R. H., vice president, Whiting Foundry Equipment Co., Harvey, Ill.
Bowring, W. W., salesman, E. J. Woodison Co., Detroit.
Boyd, John S., superintendent, Galion Iron Works & Mfg. Co., Galion, O.
Bradbury, R. C., salesman, Carborundum Co., Chicago.
Bradford, L. I., service engineer, Muncie Foundry & Machine Co., Muncie, Ind.
Bradley, W. P., foundry superintendent, American Bridge Co., Ambridge, Pa.
Brandon, G. R., vice president, Whiting Foundry Equipment Co., Harvey, Ill.
Brant, William J., Pittsburgh, Pa.
Braucher, P. S., foundry manager, P. & R. Ry., Reading, Pa.
Breda, Charles A., foundry foreman, Allyne & Ryan, Cleveland.
Breining, Wm., foreman, core room, Haskell & Barker Co., Michigan City, Ind.
Brough, Edward N., foundry superintendent, E. & T. Fairbanks & Co., St. Johnsbury, Vt.
Broun, Jas. H., sales manager, Sullivan Machinery Co., Chicago.
Brown, Chalmers S., president, Chalmers Mfg. Co., Lima, O.
Brown, J. F., foundry superintendent, Morgan Engineering Co., Alliance, O.
Brown, L. K., secretary, Interstate Sand Co., Zanesville, O.
Brownfield, E. S., district sales manager, U. S. Graphite Co., St. Louis.
Buckwalter, C. F. P., assistant sales manager, David Lupton's Sons Co., Philadelphia.
Bunnell, F. O., vice president, Southern Wheel Co., St. Louis.
Bunting, E. L., salesman, Buckeye Products Co., Cincinnati.
Burchard, M. H., Westinghouse Air Brake Co., Chicago.
Burgess, W. H., vice president, International Malleable Iron Co., Guelph, Ont.

BURMAN, GEORGE A., department manager, E. J. Woodison Co., Detroit.
BURNETT, FRANK C., foundry foreman, Lennox Furnace Co., Marshalltown, Iowa.
BURTON, J. R., secretary-treasurer, Geneva Foundry & Machine Co., Geneva, Ill.
BUSS, JACOB, foreman, Albany Foundry Co., Albany, N. Y.
BYRNE, THOS. A., superintendent, pattern shop, Youngstown Sheet & Tube Co., Youngstown, O.

CAMPBELL, DANIEL, salesman, Frederic B. Stevens, Detroit.
CAMPBELL, H. L., metallurgist, Industrial Works, Bay City, Mich.
CARHART, M. G., sales engineer, Industrial Electric Furnace Co., Chicago.
CARMAN, E. S., secretary, Cleveland Osborn Mfg. Co., Cleveland.
CARMICHAEL, H. J., superintendent, McKinnon Industries, Ltd., St. Catharines, Ont.
CARNALL, foundry foreman, Oil Well Supply Co., Oil City, Pa.
CARNS, WILLIAM F., advertising manager, *Brass World*, New York.
CARROLL, STEPHEN S., foundry foreman, Geo. B. Limbert, East Chicago, Ind.
CARSON, C. F., foundry superintendent, Wellman-Seaver-Morgan Co., Akron, O.
CHAMBER, W., foundry manager, Garden City Sand Co., Chicago.
CHRISTY, A. R., treasurer, Fremont Stove Co., Fremont, O.
CLAMER, G. H., vice president, Ajax Metal Co., Philadelphia.
CLARE, A. N. W., vice president, Clare Bros. Co., Ltd., Preston, Ont.
CLARK, A. M., district manager, Columbia Steel Co., Portland, Oreg.
CLARK, JOHN O., assistant to vice president, Mumford Molding Machine Co., Chicago.
CLAUSEN, L. R., manager, Dain Mfg. Co., Ottumwa, Iowa.
CLELAND, S. H., eastern manager, Black Products Co., Chicago.
CNUTH, P. C., foundry superintendent, Ingersoll-Rand Co., Phillipsburg, N. J.
COCHRANE, W. W., Pawling & Harnischfeger Co., Milwaukee.
COLE, F. V., circulation manager, Penton Publishing Co., Cleveland.
COLMAN, ARTHUR E., superintendent, Anthes Foundry, Ltd., Winnipeg, Man.
COLMAN, J. H., salesman, Tabor Mfg. Co., Philadelphia.
CONDIT, JOHN A., district representative, Joseph Dixon Crucible Co., Jersey City, N. J.
CONNOR, W. P. J., general agent, Goodrich Transit Co., Milwaukee.
CONWAY, E. A., Fremont Stove Co., Fremont, O.
CONWAY, JOHN L., superintendent, Fremont Stove Co., Fremont, O.
CONWOOD, LUTHER G., general manager, Blystone Mfg. Co., Cambridge Springs, Pa.
COOK, OLIVER, salesman, U. S. Silica Co., Chicago.
COOMBES, GEORGE, manager, Kerr & Coombes, Hamilton, Ont.
COOPER, CHAS., superintendent, Cooper Foundry Co., Atchison, Kans.
COSDUYEY, ALFRED, president, Drill City Foundry Co., Denver, Colo.
COSTLEY, S. R., J. S. McCormick, Pittsburgh.
COTTRILL, GEO. F., vice president, Green Car Wheel Mfg. Co., St. Louis, Mo.
COUGHLIN, M., sales agent, American Gum Products, New York.

CRAWFORD, J. L., engineer, Cadillac Motor Car Co., Detroit.
CRAWFORD, ROBERT, president, Atlas Foundry Co., Detroit.
CRAWLEY, foundry superintendent, Consolidated Press Co., Hastings, Mich.
CULLMAN, C. J., superintendent, Western Foundry Co., Chicago.
CULP, HERBERT R., general manager, Temple Malleable Iron & Steel Co., Temple, Pa.
CUTHBERT, S. B., superintendent of foundries, Carnegie Steel Co., Braddock, Pa.

DAEHM, E. J., foreman, Stowell Co., South Milwaukee.
DALLWIG, B., secretary-treasurer, Wisconsin Aluminum Foundry Co., Manitowoc, Wis.
DANIEL, C. P., engineer, Enterprise Foundry & Machine Co., Bristol, Va.-Tenn.
DAPOGNY, A., superintendent, Chicago Steel Foundry Co., Chicago.
DARISSE, A., manager, La Compagnie Desjardins, St. Andre, Que.
DAVIES, D. J., foundry superintendent, L. Wolff Mfg. Co., Chicago.
DAVISON, G. L., vice president, Southern Ferro Alloys Co., Chattanooga, Tenn.
DEAKINS, H. E., salesman, Cleveland Osborn Mfg. Co., Cleveland.
DEAN, W. J., foundry superintendent, Saco-Lowell Shops, Biddeford, Me.
DEEMS, G. B., superintendent, Elmwood Castings Co., Cincinnati.
DE LANO, C. B., general manager, Kalamazoo Stove Co., Kalamazoo, Mich.
DENISON, A. C., foundry superintendent, Fulton Foundry & Machine Co., Cleveland.
DENNEGAN, A. I., foundry superintendent, Power Specialty Co., Dansville, N. Y.
DILLER, H. E., chief of testing laboratory, General Electric Co., Erie, Pa.
DINGS, ALVIN, president, Magnetic Mfg. Co., Milwaukee.
DITTY, F. L., salesman, Federal Foundry Supply Co., Cleveland.
DITTY, RALPH, treasurer, Federal Foundry Supply Co., Cleveland.
DODDRIDGE, E. T., sales engineer, Cleveland Osborn Mfg. Co., Cleveland.
DOFFY, J., manager, King Optical Co., New York.
DOLAN, M. E., general foreman, Louisville-Nashville Ry., Louisville, Ky.
DONAHUE, W. J., general superintendent, American Malleable Co., Lancaster, N. Y.
DONALD, H. R., manager, Cleveland Osborn Mfg. Co., Cleveland.
DORAN, W. S., president, Alberger Pump & Condenser Co., New York.
DRIVER, F. M., vice president, Driver-Harris Co., Newark, N. J.
DROLET, E., foundry superintendent, F. X. Drolet Co., Quebec, Can.
DUISDIEKER, C. H., proprietor, Duisdieker Foundry & Mfg. Co., Pekin, Ill.
DUNBECK, J. R., superintendent, T. H. Symington Co., Rochester, N. Y.
DUNCAN, J. M., foreman, pattern department, Detroit Steel Casting Co., Detroit.
DWIGHT, J. H., vice president, Belle City Malleable Iron Co., Racine, Wis.
DWYER, EMMET, vice president, Michigan Stove Co., Detroit.

EDWARDS, A. D., president, Woodruff & Edwards Co., Elgin, Ill.
EDWARDS, E., salesman, Carborundum Co., Niagara Falls, N. Y.
EDWARDS, LEROY, treasurer, Canadian Driver Harris Co., Walkerville, Ont.
EICHMAN, R. L., foundry superintendent, Bettendorf Co., Bettendorf, Iowa.
EITEMAN, W. L., superintendent, Williams White & Co., Moline, Ill.
ELLIOT, FRANK F., assistant superintendent, brass foundry, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
ELLIS, C. H., salesman, H. E. Pridmore, Chicago.
ELLIS, F. A., advertising manager, Russel Wheel & Foundry Co., Detroit.
ELLIS, G. R., Canada Stove Co., Montreal, Que.
EMERSON, CARL, foundry foreman, Deere & Co., Moline, Ill.
EMERSON, W., foundry superintendent, Electric Steel & Metals Co., Welland, Ont.
ENGMAN, J. M., Carborundum Co., Niagara Falls, N. Y.
ERSTROM, W. H., inspector, Lakeside Malleable Castings Co., Racine, Wis.
ESTEP, H. C., editorial director, Penton Publishing Co., Cleveland.
EVANS, DAVID, president, Chicago Steel Foundry Co., Chicago.
EVANS, G. M., salesman, Western Electric Co., New York.
EVANS, J. E., salesman, S. Obermayer Co., Chicago.

FAITZ, G. A., department superintendent, National Malleable Castings Co., Chicago.
FAULK, M. J., demonstrator, McCrosky Reamer Co., Meadville, Pa.
FELTER, S. J., general superintendent, Allyne-Ryan Foundry Co., Cleveland.
FENSTERMACHER, JOHN D., sales manager, Columbia Steel Co., San Francisco.
FENTON, W., salesman, S. Obermayer Co., Chicago.
FERGUSEN, R. B., salesman, Buckeye Products Co., Cincinnati.
FINDLEY, E., central western manager, *The Iron Age*, Cleveland.
FINK, B. O., manager, Auburn Foundry, Auburn, Ind.
FINN, C., master machinist, Belle City Malleable Iron Co., Racine, Wis.
FISCHER, ANTHONY, foundry foreman, United Engineering & Foundry Co., Pittsburgh.
FISCHER, G. J., manager, Modern Iron Works, Quincy, Ill.
FISCHER, R. E., superintendent cleaning department, Ohio Steel Foundry Co., Lima, O.
FISCHER, W. E., superintendent of foundries, M. H. & T. R. R., Parsons, Kans.
FISHER, J. E., efficiency engineer, Ohio Steel Foundry Co., Lima, O.
FISHER, H. F., foundry foreman, Farquhar Co., York, Pa.
FISK, L. A., secretary-treasurer, Fisk-Jencks Foundry Co., Geneva, Ill.
FITZGERALD, E. J., assistant sales manager, Laconia Car Co., Laconia, N. H.
FITZPATRICK, W. H., sales manager, S. Obermayer Co., Syracuse, N. Y.
FLEURY, E. B., Canadian salesman, S. Obermayer Co., Chicago.
FORBES, M., Tabor Mfg. Co., Philadelphia.
FORGEOT, G. C., superintendent, Snow Steam Pump Works, Buffalo, N. Y.
FORSBERG, O. A., engineer, Crane Co., Chicago.
FORSBERG, S. H., purchasing department, Deere & Co., Moline, Ill.

Forthman, J. W., salesman, Hill & Griffith Co., Cincinnati.
Foster, E. H., vice president, Power Specialty Co., Dansville, N. Y.
Fowler, H. D., sales department, J. S. McCormick Co., Pittsburgh.
Fraser, W. D., Berkshire Mfg. Co., Cleveland.
Frey, W. F., pattern foreman, H. Vogt Machine Co., Louisville, Ky.
Frink, G., president, Washington Iron Works, Seattle, Wash.
Fry, J. A., superintendent, Detroit Stove Works, Detroit.
Frye, W. C., president, Chain Belt Co., Milwaukee.
Fuller, B. D., superintendent of foundries, Westinghouse Electric & Mfg. Co., Cleveland.
Fuller, G. A., Federal Foundry Supply Co., Cleveland.
Fulton, A. M., superintendent, Fort Pitt Malleable Iron Co., Pittsburgh.
Furlong, H. P., Detroit manager, Whiting Foundry Equipment Co., Harvey, Ill.

Galligan, J. A., sales manager, Pickands, Brown & Co., Chicago.
Galloway, J. H., sales manager, Cleveland Osborn Mfg. Co., Cleveland.
Galvin, J. E., vice president, Ohio Steel Foundry Co., Lima, O.
Garber, J. B., superintendent, Deming Co., Salem, O.
Garrard, J. G., superintendent, Northwestern Malleable Iron Co., Milwaukee.
Gartland, T. H., general manager, Gartland Toledo Foundry Co., Toledo, O.
Gengenbacher, J., foundry foreman, Youngstown Foundry & Machine Co., Youngstown, O.
Genske, O. A., superintendent, Illinois Malleable Iron Co., Chicago.
Gertz, S., engineer in charge of publicity, C. O. Bartlett & Snow Co., Cleveland.
Gibney, J. W., manager, W. P. Taylor Co., Buffalo.
Gibson, A. E., superintendent, Wellman-Seaver-Morgan Co., Cleveland.
Gilbert, C. F., president, A. Gilbert & Sons Brass Foundry Co., St. Louis.
Gilbert, C. S., superintendent, Canada Iron Foundries, St. Thomas, Ont.
Gilbert, J. A., secretary, A. Gilbert & Sons Brass Foundry Co., St. Louis.
Gilbreth, F. B., consulting engineer, Providence, R. I.
Glass, J. M., salesman, Hill & Griffith Co., Cincinnati.
Glass, W. L., foundry foreman, Deming Co., Salem, O.
Glasscot, T., salesman, Pickands, Brown & Co., Milwaukee.
Goehringer, C. J., president, Buckeye Products Co., Cincinnati.
Goergen, P. M., superintendent, Howard Iron Works, Buffalo.
Golden, A. P., superintendent, brass foundry, Bethlehem Steel Co., Sparrows Point, Md.
Golden, J. R., general manager, Golden's Foundry & Machine Co., Columbus, Ga.
Goldsmith, O., assistant superintendent, W. D. Allen Mfg. Co., Chicago.
Goldstine, N. T., assistant superintendent, Michigan Motor Castings Operating Co., Flint, Mich.
Gordon, F. E., president, Gordon Sand Co., Conneaut, O.
Gosiger, L. A., secretary, S. Obermayer Co., Cincinnati.
Green, A. T., president, Hub City Iron Works, Aberdeen, S. D.
Green, H., superintendent, machine shop, Falk Co., Milwaukee.
Gregg, W. K., metallurgist, Sivyer Steel Casting Co., Milwaukee.

GREGORY, W. T., general supervisor of castings and patterns, Michigan Motor Casting Co., Flint, Mich.
GRIMSHAW, R., Ph. D., consulting engineer, C. E. Knoeppel & Co., New York.
GRONBAK, H. O., assistant general superintendent, Werner & Pfleiderer Co., Saginaw, Mich.
GROTE, F., JR., foundry foreman, F. Grote Mfg. Co., Evansville, Ind.
GROTE, F., SR., president, F. Grote Mfg. Co., Evansville, Ind.
GRUSS, W. J., pig iron sales executive, Pickands Mather & Co., Cleveland.
GYSIN, C. L., salesman, Buckeye Products Co., Cincinnati.

HAGGMAN, W. F., branch manager, E. J. Woodison Co., Seattle, Wash.
HALFAHRT, W. A., superintendent, Kansas City Hay Press Co., Kansas City, Mo.
HALL, F. B., assistant superintendent, National Malleable Castings Co., Chicago.
HALLCROFT, W. H., foreman, Central Foundry Co., Marshalltown, Iowa.
HALLUP, C., toolroom foreman, Nordberg Mfg. Co., Milwaukee.
HAMILTON, W., superintendent of foundries, Newport News Shipyard, Newport News, Va.
HAMMOND, J. H., foundry superintendent, Taylor Forbes Co., Guelph, Ont.
HANKS, G. R., foundry manager, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
HANN, W. J., superintendent, Henry-Miller Foundry Co., Canton, O.
HANSEN, F. J., department superintendent, Crane Co., Chicago.
HANSEN, I., foreman, Crane Co., Chicago.
HANSEN, J., foundry superintendent, Terre Haute Malleable & Mfg. Co., Terre Haute, Ind.
HANSEN, J. P., general superintendent, Dickerson Foundries, Inc., Waukegan, Ill.
HARRINGTON, R. F., chemist and metallurgist, Hunt-Spiller Mfg. Corp., Boston.
HART, J. W., foreman, West Steel Casting Co., Cleveland.
HART, L. O., vice president, Driver Harris Co., Harrison, N. J.
HARTLE, J., superintendent, De La Vergne Machine Co., New York.
HARWAY, T. H., works manager, Ohio Steel Foundry Co., Springfield, O.
HASTINGS, G. B., district manager, Ludlum Electric Furnace Co., Chicago.
HASTINGS, W. A., superintendent, Canada Iron Foundries, Hamilton, Ont.
HAUSFELD, J. E., treasurer, Hausfeld Co., Harrison, O.
HAUTNER, G., president, Dayton Steel Foundry, Dayton, O.
HAYES, F., president, Superior Iron Works Co., Superior, Wis.
HAYES, M. J., superintendent, U. S. Cast Iron Pipe & Foundry Co., Bessemer, Ala.
HAYES, R. W. E., general manager, Hayes Pump & Planter Co., Galva, Ill.
HEATH, L. W., general manager, Consolidated Press Co., Hastings, Mich.
HEFT, O., superintendent, machine shop, Brillion Iron Works, Brillion, Wis.

HEGMAN, A., foundry foreman, American Hoist & Derrick Co., St. Paul, Minn.
HEIBY, C. G., vice president, H. Mueller Mfg. Co., Ltd., Sarnia, Ont.
HEINKEL, J., manager, Cooper Foundry Co., Atchison, Kans.
HEMENWAY, H., vice president, Peoria Malleable Castings Co., Peoria, Ill.
HENDERSON, C. M., superintendent, H. C. Macauley Foundry Co., Berkeley, Cal.
HERMAN, B. L., assistant advertising manager, *The Iron Age*, New York.
HERNEMAN, W. F., assistant general foreman, Allis Chalmers Mfg. Co., Milwaukee.
HERRMAN, M. W., president, Madison Foundry Co., Cleveland.
HETZEL, F. V., chief engineer, Link-Belt Co., Indianapolis, Ind.
HIBBINS, T. A., general business manager, Stevenson Co., Wellsville, O.
HILDRETH, N. E., superintendent, Cushman Motor Works, Lincoln, Neb.
HILL, JOHN, Hill-Brunner Foundry Supply Co., Cincinnati.
HITCHINS, F. O., manager, Headford Bros. & Hitchins Foundry, Waterloo, Iowa.
HOEHN, C., vice president, Enterprise Foundry Co., San Francisco.
HOFFMAN, R. S., salesman, E. J. Woodison Co., Detroit.
HOLLAND, R. S., manager, Foundrymen's Supply Co., Milwaukee.
HOLLINS, C. D., salesman, Black Products Co., Chicago.
HOLLOWELL, J. M., vice president, Spalding Foundry Co., Atlanta, Ga.
HOLMES, H. A., sales manager, Standard Pulley Co., Cincinnati.
HOLMES, H. G., engineer, Novo Engine Co., Lansing, Mich.
HOPPER, G. H., foreman, Pratt & Letchworth Co., Brantford, Ont.
HOPPER, R. J., superintendent, Pratt & Letchworth Co., Brantford, Ont.
HORNER, S. I., foundry superintendent, Midwest Engine Co., Indianapolis.
HORTON, P. S., manager, Wilmington Castings Co., Wilmington, O.
HOSTER, L., JR., vice president, Bessemer Foundry & Machine Co. Bessemer, Ala.
HOWELL, A. E., superintendent of manufactures, Phillips & Buttorff Mfg. Co., Nashville, Tenn.
HOWES, G. W., general superintendent, Beckwith Co., Dowagiac, Mich.
HOYT, C. E., exhibition manager, American Foundrymen's Association, Chicago.
HUBBARD, S. W., Rogers Brown & Co., Cleveland.
HUDSON, F. M., works manager, Ohio Steel Foundry, Bucyrus, O.
HUGHES, W. E., general foundry foreman, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
HUMMEL, A. S., metallurgist, Wm. Wharton Jr. & Co., Easton, Pa.
HUMPHREY, J., foreman, Brillion Iron Works, Brillion, Wis.
HUTTON, W. W., salesman, Hill & Griffith Co., Cincinnati.

IDEN, V. G., associate editor, *The Foundry*, Cleveland.
INGERSOLL, G. W., president, Ingersoll Foundry, Toledo, O.

JACKOT, F. F., Milwaukee representative, Detroit Steel Products Co., Detroit.
JAMES, G., pattern superintendent, American Engineering Co., Philadelphia.

JAMESON, A. H., vice president, Bayonne Steel Casting Co., Bayonne, N. J.
JAMIESON, G. S., assistant general superintendent, Crane Co., Chicago.
JANSSEN, W. A., operating manager, Canadian Steel Foundries, Ltd., Montreal, Que.
JASPER, S. H., representative, Penton Publishing Co., Cleveland.
JENNISON, F. E., vice president, Jennison-Wright Co., Chicago.
JENSEN, M., superintendent, V. F. Bendixen Foundry, Chicago.
JOHNSON, A., machine shop foreman, Nordberg Mfg. Co., Milwaukee.
JOHNSON, C. S., salesman, N. H. Sand Blast Co., New Haven, Conn.
JOHNSON, D. A., manager Chicago office, Joseph Dixon Crucible Co., Jersey City, N. J.
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JOHNSON, L., salesman, S. Obermayer Co., Chicago.
JOHNSON, S. C., superintendent, Pelton Steel Co., Milwaukee.
JOHNSON, S. E., foundry superintendent, A. J. Lindeman & Hoverson Co., Milwaukee.
JOHNSON, S. T., vice president, S. Obermayer Co., Chicago.
JOHNSON, W. J., general foreman, Industrial Works, Bay City, Mich.
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JONES, G. B., general manager, Globe Stove & Range Co., Kokomo, Ind.
JONES, W. B., superintendent, Mueller Metals Co., Port Huron, Mich.
JORDAN, A. F., salesman, E. J. Woodison Co., Detroit.

KAINE, W. F., president, T. P. Kelly & Co., Inc., New York.
KEAGLE, H. V., chief draftsman, Henry E. Pridmore, Chicago.
KEELER, S., salesman, E. J. Woodison Co., Detroit.
KEEN, E. A., foundry superintendent, Deming Co., Salem, O.
KELLER, H. D., superintendent, Homer Furnace Co., Homer, Mich.
KELLER, J. M., foundry manager, American Car & Foundry Co., St. Louis.
KELLER, W. F., president, Keller Mfg. Co., Minneapolis.
KELLIE, C., superintendent, Pacific Foundry Co., San Francisco.
KELLY, J. P., sales manager, S. Obermayer Co., Glasgow, Scotland.
KELLY, W. L., manager, Jackson Brass Foundry Co., Jackson, Mich.
KEMM, H. E., salesman, Carborundum Co., Niagara Falls, N. Y.
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MILLER, C. W., general foreman, General Electric Co., Erie, Pa.
MILLER, G. C., foreman, Vulcan Plow Co., Evansville, Ind.
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Peterson, O. J., representative, S. Obermayer Co., Chicago.
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Phelps, S. B., foundry superintendent, Sharples Separator Co., West Chester, Pa.
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PRIDMORE, MRS. E. M., Henry E. Pridmore, Chicago.
PRIDMORE, H. A., Henry E. Pridmore, Chicago.
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SHERMAN, H. B., president, Consolidated Press Co., Hastings, Mich.
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WALKER, J. E., general manager, Eastern Malleables Iron Co., Wilmington, Del.
WALLACE, R. B., manager, Wallace Machine & Foundry Co., Lafayette, Ind.

WALLACE, R. S. B., foundry superintendent, National Cash Register Co., Dayton, O.
WALLEN, A. N., salesman, S. Obermayer Co., Chicago.
WALTER, J. F., Chicago branch manager, T. P. Kelly & Co., Inc., New York.
WALTON, H. G., product manager, Bethlehem Steel Co., South Bethlehem, Pa.
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WARD, J. H., superintendent, Illinois Malleable Iron Co., Chicago.
WARD, T. E., treasurer, The Stowell Co., South Milwaukee, Wis.
WARK, W. J., manager, E. J. Woodison Co., Buffalo, N. Y.
WATERBURY, H. L., superintendent, Link-Belt Co., Indianapolis.
WAY, L. A., assistant to president, Lewis Foundry & Machine Co., Pittsburgh.
WEAVER, A. B., salesman, Rogers, Brown & Co., Chicago.
WEAVER, H. G., Rogers, Brown & Co., Cincinnati.
WEAVER, MYRON H., pattern superintendent, Terre Haute Malleable & Mfg. Co., Terre Haute, Ind.
WEGELIN, CHARLES, manager, Dixie Brass & Foundry Co., Bessemer, Ala.
WEGELIN, RUDOLPH, foundry foreman, Joubert & Goslin Foundry Co., Birmingham, Ala.
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WEILER, W., salesman, Chicago Steel Co., Chicago, Ill.
WEISS, C. F., sales engineer, Mumford Molding Machine Co., Chicago.
WERCKMAN, M. M., salesman, E. J. Woodison Co., Detroit.
WEST, J. M., foreman, Bosworth & Ard Machine & Foundry Co., Anniston, Ala.
WEST, R. H., president, West Steel Casting Co., Cleveland.
WHITE, S. H., superintendent, West Side Foundry Co., Troy, N. Y.
WHITMORE, E., superintendent, Detroit Foundry Co., Detroit.
WHITNEY, A. W., metallurgist, Enterprise Foundry & Machine Works, Bristol, Tenn.-Va.
WHYTE, D. M., representative, Mumford Molding Machine Co., Chicago.
WIBB, J. F., manager manufacturing department, E. J. Woodison Co., Detroit.
WILL, J. M., sales manager, Electric Steel Co., Chicago.
WILLIAMS, B. C. W., molder, Indiana Foundry Co., Indiana, Pa.
WILLSON, C. A., manager, Anthes Foundry, Ltd., Winnipeg, Man.
WILSON, T. A., manager, Rogers, Brown & Co., Pittsburgh, Pa.
WILSON, T. A., Rogers, Brown & Co., Cincinnati.
WILSON, W. M., salesman, Bassett Co., Chicago.
WINLOCK, HARVEY F., secretary, Barbour Stockwell Co., Cambridge, Mass.
WINTERS, J., foreman, Dayton Steel Foundry, Dayton, O.
WITMAN, D. N., metallurgist, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
WITT, A. J., factory manager, Hoover Suction Sweeper Co., North Canton, O.
WITTERS, J. M., salesman, E. J. Woodison Co., Detroit.
WOLF, J. A., superintendent, Covel Mfg. Co., Benton Harbor, Mich.
WOLFF, C. J., vice president, L. Wolff Mfg. Co., Chicago.
WOLKOW, I. L., superintendent, metal goods department, F. Wolkow & Sons, Louisville, Ky.
WOOD, W. B., secretary, Central Foundry Co., Marshalltown, Iowa.
WOODEN, P. M., foundry superintendent, Aultman & Taylor Machinery Co., Mansfield, O.
WOODISON, C. H., vice president, E. J. Woodison Co., Toronto, Ont.

Woodison, E. J., president, E. J. Woodison Co., Detroit.
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Workman, E. D., general manager, York Hardware & Brass Works, York, Pa.
Wright, J. A., secretary-treasurer, Enterprise Brass Foundry Co., Tacoma, Wash.
Wrightman, G., secretary-treasurer, Iowa State Manufacturers' Association, Des Moines, Iowa.
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Yavitz, J. T., sales manager, The Loewenthal Co., Chicago.
Young, G. A., superintendent, Meadows Mfg. Co., Pontiac, Ill.

Zachert, A. R., general superintendent, Power Specialty Co., Dansville, N. Y.
Zeller, B. L., Western Foundry Co., Chicago.
Zerner, E. A., foundry foreman, H. Vogt Machine Co., Louisville, Ky.
Zimmerman, G. J., manager, Central Specialty Co., Detroit.
Zipp, John, superintendent, Cahill Iron Works, Chattanooga, Tenn.
Zubell, A. C., secretary, Universal Foundry Co., Oshkosh, Wis.

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